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APPRAISAL OF AIR POLLUTION IN TEXAS

Otto Paganini, et al

Texas State Department of Health
Austin, Texas

1958

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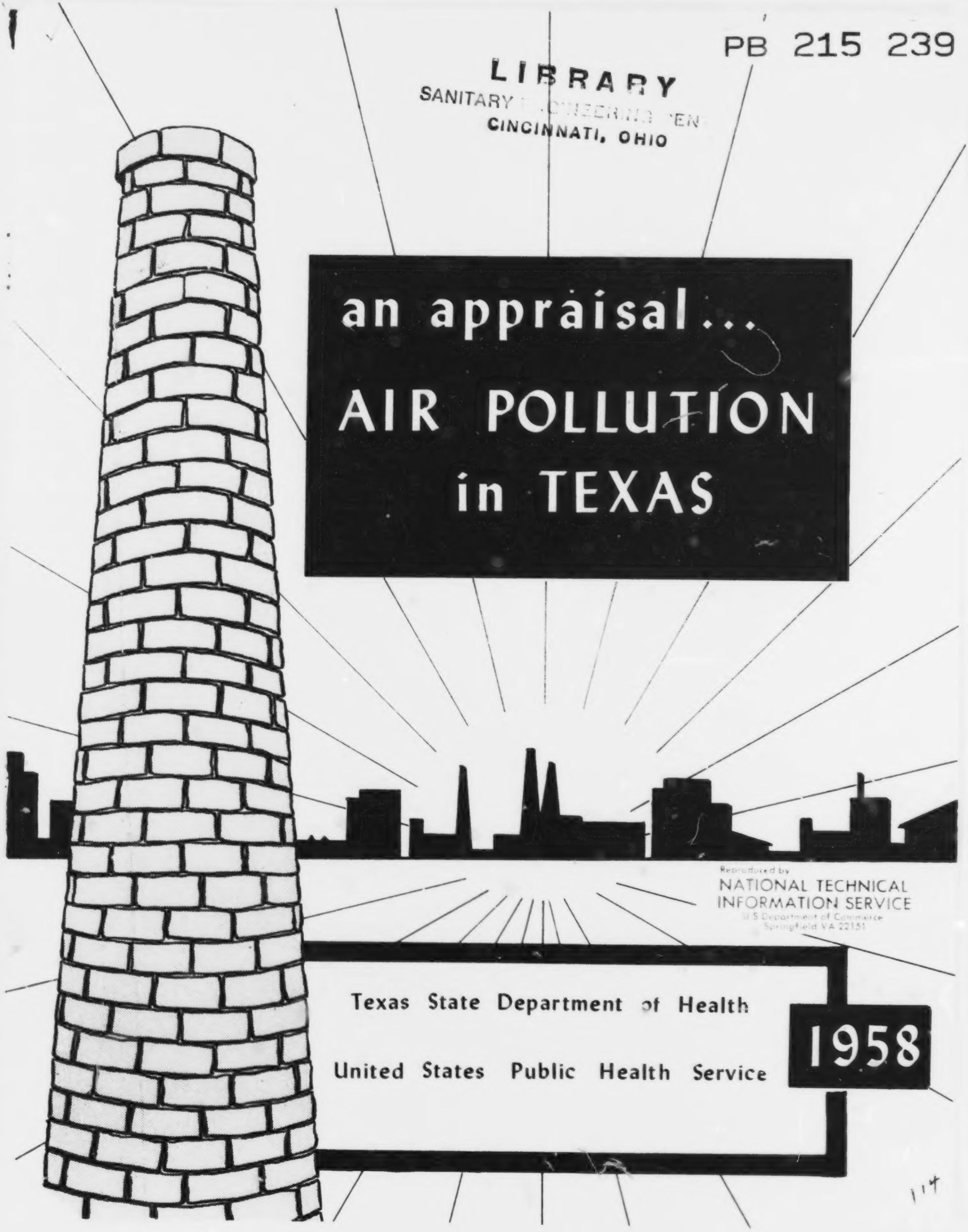

an appraisal...
AIR POLLUTION in TEXAS

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Texas State Department of Health

United States Public Health Service

1958

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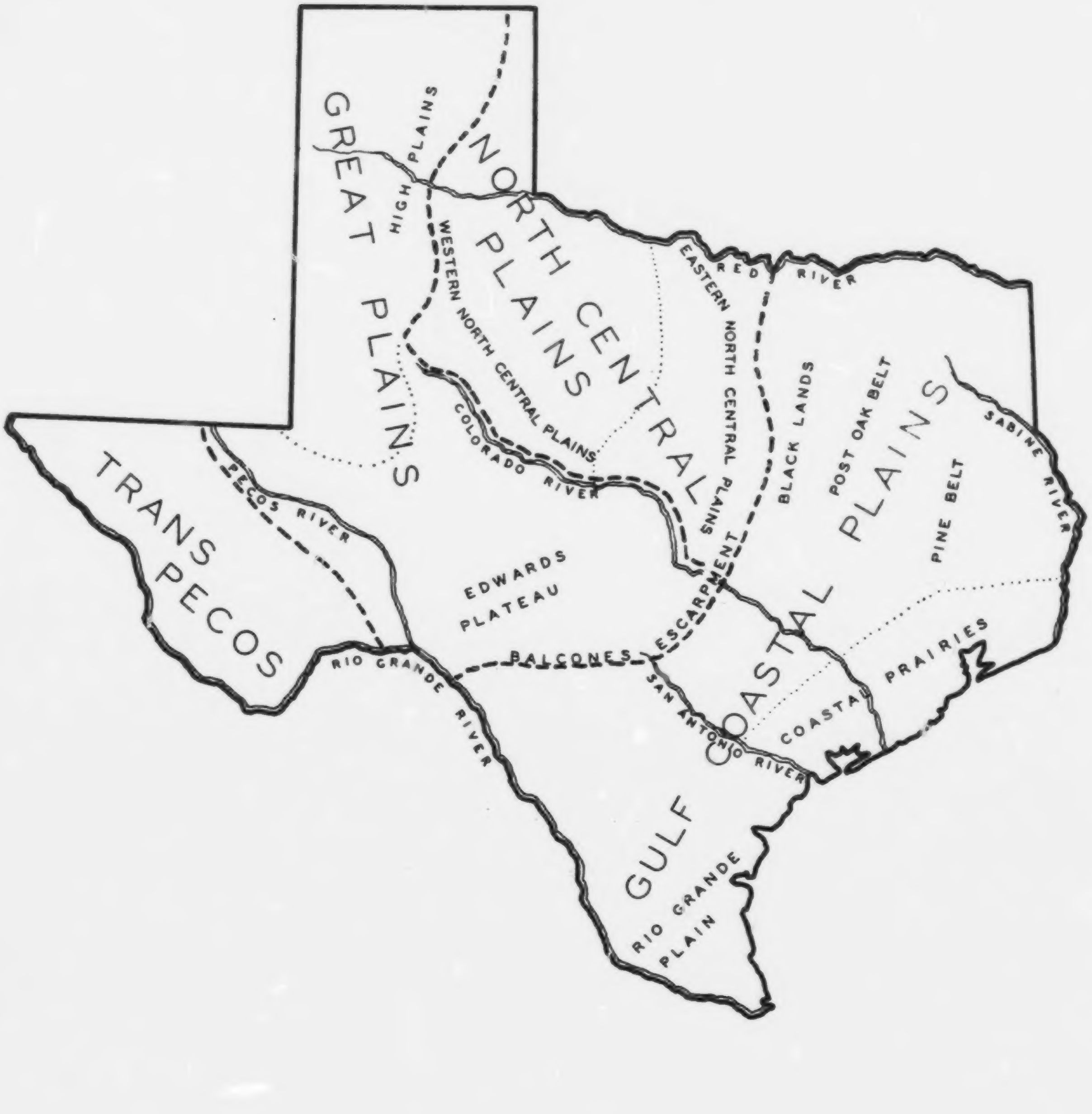
PHYSIOGRAPHIC AREAS OF TEXAS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HIGH PLAINS
NORTH CENTRAL PLAINS
WESTERN NORTH CENTRAL PLAINS
EASTERN NORTH CENTRAL PLAINS
RED RIVER
BLACK LANDS
POST OAK BELT
PINE BELT
SABINE RIVER
GULF COASTAL PLAINS
COASTAL PRAIRIES
TRANS PECOS
PECOS RIVER
COLORADO RIVER
EDWARDS PLATEAU
BALCONES ESCARPMENT
RIO GRANDE RIVER
SAN ANTONIO RIVER
RIO GRANDE PLAIN

APPRAISAL OF AIR POLLUTION IN TEXAS

REPORT OF A COOPERATIVE SURVEY
BY THE
TEXAS STATE DEPARTMENT OF HEALTH
AND THE
U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE

December 1957 through July 1958

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State and Community Services

Details of illustrations in
this document may be better
studied on microfiche

TEXAS STATE DEPARTMENT OF HEALTH

Austin, Texas

1958

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Those contributing to the success of this project and report include:

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Health Officers

City Officials

Chambers of Commerce

Industrial Establishments

Industrial Associations

Private Associations

Colleges and Universities

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State Agencies

Federal Agencies

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SUMMARY

This state-wide appraisal of the factors relative to air pollution in Texas resulted from the interest and concern expressed by citizens and organizations in the State. Realizing the need for action, the Texas State Department of Health requested assistance from the United States Public Health Service in conducting a general appraisal to determine the status of air pollution in the State and the need for additional activity on the part of the State government in meeting its air pollution problems.

Data used in preparing this report were obtained by interviews with informed individuals, by direct observations, by questionnaires, and by review of existing information. Information was secured which would indicate the occurrence of air pollution problems, the general nature of local control programs, the presence of potential pollution problems and adverse pollution factors, and the need for future activity to insure adequate protection of the vital air resources of the State. The appraisal was conducted from December 1957 through July 1958.

Air pollution problems exist in many areas of the State. Of the 71 larger cities in the State, to which field visits were made, over three-fourths (56 cities) were found to have objectionable air pollution in their area. Of the 410 questionnaires returned from the city and county health officers of the smaller towns and rural areas of the State, 194 indicated the presence of objectionable pollution. The number of problems and their general sources are:

Type of Pollution	Areas with Air Pollution Problems of Each Type		
	Existence of Problems Determined by		Total
	Field Visits	Questionnaire	
Industrial	39	46	85
Agricultural	26	114	140
Municipal	27	24	51
Domestic	6	10	16
Total	98	194	292

Industry contributes a great variety and quantity of pollutants to the atmosphere. These emissions are largely, but not exclusively, concentrated in the urban areas. Of the 71 large cities visited, 39 (55 percent) experienced objectionable pollution from industrial emissions. Among the 410 small towns and rural counties covered by questionnaire, 46 (11 percent) indicated problems due to industrial emissions. Emissions from the chemical and allied products industries, in the form of fumes, dusts, smokes, and odors were the source of complaints in 17 cities visited, and were reported on eight questionnaires. Fertilizer and carbon black plants were the chief offenders. In all 25 cases the pollutants caused discomfort to the citizens; in five cases they caused property damage; and in four cases they caused damage to vegetation.

Gases associated with oil production caused discomfort to citizens in five cities visited and were reported on two questionnaires. These emissions caused damage to property in three areas, and damage to vegetation in two areas. Refinery emissions (gases, fumes, and odors) caused discomfort to citizens in six cities visited and in four area reported by questionnaires. In five of these areas the emissions reportedly caused damage to property and to vegetation. Other particularly outstanding pollution sources include the following industries: primary metals, pulp and paper (especially odors from pulp mills), stone, clay and glass (particularly cement plants), and rubber products. Complaints from 21 cities visited and from 11 questionnaires concerned emissions from the food and kindred products industries, primarily dust from cottonseed crushing and oil mills and feed plants. These are classified as industrial sources.

The emissions classified as agricultural were primarily dust and smoke from cotton ginning operations; 130 of the total 140 reported areas with agricultural problems were from these operations. The problems and complaints associated with these gins are primarily in the more rural areas. The cotton ginning operations are seasonal; the emissions create objectionable conditions during several months each year. Lint and dust frequently collect or settle on adjacent property creating unsightly conditions and along with smoke from incinerating trash, interfere with the personal enjoyment of property. As reported by health officers on returned questionnaires, these emissions cause or aggravate respiratory ailments of exposed citizens. The use of insecticides and herbicides, while causing few complaints, cause pollution problems which are quite important from a health standpoint. Improper or careless application of these poisons by planes has resulted in fish kills in streams, illness to migrant laborers, and acute illness of a mail carrier who was accidentally dusted.

Of the communities with municipal problems, 35 problems concerned objectionable odors from sewage treatment facilities, while 16 were due to smoke and odors from burning dumps or odors from open dumps. Municipal sources were problems in all size ranges of cities, but were more objectionable in the smaller cities where dumps and sewage works tend to be nearer residential areas, and where fewer major sources of pollution exist.

Problems in the municipalities with domestic type sources consist mainly of odors from keeping fowl and animals in or near residential areas. A few municipalities experience smoke from backyard burning of trash or refuse.

Five areas in the State reported the existence of air pollution sources located in other political jurisdictions. Two of these were international in character, one involving El Paso, Texas, and Juarez, Mexico and the other involving Laredo, Texas and Nuevo Laredo, Mexico. The remaining three interjurisdictional problems involved the following pairs of counties: Jasper and Jefferson, Harris and Galveston, and Angelina and Nacogdoches.

The problems just enumerated are of a "localized" nature, ones where there is an outstanding individual source of pollutants which is readily observable, and a relatively limited area where the effect of the pollutants is observed. This is the type of pollutation of which local officials and citizens are readily aware. In the larger communities, however, there is another "type" of air pollution—a community air pollution problem. In these urban areas, a multitude of individually innocuous emissions from automobiles, space heaters, water heaters, etc., exhibit a cumulative effect as they pour forth into a limited air space.

Emissions which are of no consequence individually become a public health threat through sheer numbers. The great growth of some of the State's urban areas, indicates a growing problem of this type. Instead of a "there is the source" problem, localities will be concerned more and more with a "there is something in the air" problem. This is the problem facing many of our great centers of population today. Somewhere in their growth, cities pass over the point where this cumulative effect of many individual sources presents a greater burden than the air can handle, and community wide problems become pronounced.

Texas experienced a 20.2 percent increase in population between 1940 and 1950, the third largest increase in the nation for this decade. The 1958 population is estimated at 9,320,000, and an 11,752,000 population is predicted by 1970. All or most of this increase will probably occur in the larger urban areas. Texas also experienced a great industrial expansion between 1947 and 1954. The number of industrial employees increased 138 percent, the payrolls increased by 215 percent, and the value added by manufacturing increased 203 percent. Most of the industrial expansion occurred in the larger urban areas. An increase in the number and severity of air pollution problems, particularly in the larger urban areas, can be anticipated because of the increased emission of pollutants associated with this large population and industrial growth, unless effective control measures are practiced.

There is a wide variation in climatological and topographical conditions in the State of Texas. The effect of these conditions on air pollution is also quite variable. In some areas, they combine to produce conditions conducive to the accumulation of pollutants; in other areas, meteorological phenomena and topographical features are such that they favor the dispersion of waste material put into the air. In general, the climatic condition of the Trans-Pecos, Great Plains, and the North Central Plains are favorable for atmospheric dispersion of pollutants. However, in these vast regions, there are places where at times the local topography will produce local variations in the wind flow and may even assist in the formation of pools of cool stable air through the mechanism of drainage winds. These conditions are conducive to the accumulation of pollutants. Fortunately, the high percentage of sunshine in these areas favors the day-to-day dissipation of these conditions.

The climatic conditions of the Gulf Coastal Plains are not as favorable for the dispersion of pollutants as are those of the northern and western parts of the State. In this region, the higher frequency of calm winds, fogs, and upper inversions produce periods when pollutants can be contained near the earth's surface. On the other hand, the topography of the area lends itself to the favorable dispersion of pollutants. Also, the high percentage of sunshine, the land-sea breeze circulation along the coast, and other meteorological features tend to inhibit a prolonged period of atmospheric stagnation.

In 1957 six Texas cities, Corpus Christi, Houston, San Antonio, Dallas, El Paso and Port O'Connor, participated in the National Air Sampling Network of the Public Health Service. Samples were collected to indicate the total particulate loading, the organic loading, and the radioactivity of the air. In 1958 under this program, El Paso, San Antonio and Corpus Christi were replaced by Waco, Austin, and Fort Worth. Except for this participation in the National Air Sampling Network only two cities (El Paso and Houston) have made measurements of air pollutants. Technical information on the amount and nature of pollutants in the State is very meager. Such data are useful and necessary in planning an effective air pollution program.

There are no State laws or regulations pertaining specifically to air pollution and only one city in the State, Dallas, has an ordinance regulating air pollution. The State Nusiance Law is used by some areas of the State in attempts to control or abate air pollution problems. However, this means has not been effective in dealing with the diverse air pollution problems of the State.

Although there are many potential resources available for research and investigation through the State's colleges and universities, very little work in the air pollution field is currently being done. In the absence of a definite state air pollution law and of specific appropriations for the purpose, the activities of the State Health Department in this field are limited to investigation of complaints when requested by the local health departments. Technical assistance is also provided.

The problems encountered in the survey affect only a small percentage of the total area of the State. Over the greater part of Texas, there are no significant air pollution problems. Yet it is in the small remaining area where air pollution problems are so important that most of Texas' citizens live. Where population and industry concentrate, air pollution problems are most likely to be present; hence they generally will affect large numbers of people living in a small percentage of the State's area.

It is concluded that air pollution problems exist in many areas of the State; that these problems arise from many sources and cause nuisance conditions, damage to property, economic loss, and injury to vegetation and animal life; that these problems are not being handled effectively by existing local activities in most instances; and that there is need for additional activity in the air pollution field at both the State and local levels. Local health departments, with reason, look to the State for technical assistance and guidance in meeting their complex air pollution problems.

RECOMMENDATIONS

From the findings of this appraisal, and based on the present technical knowledge of the field of air pollution, it is recommended that the State:

1. Place greater emphasis on the growing problem of air pollution by:
    - (a) encouraging local agencies to handle their local air pollution problems to the greatest extent that their resources permit;
    - (b) taking an active part in research on the major air pollution problems found in the State, such as those associated with cotton ginning. To this end the State should consider using its own facilities, using the facilities of the universities in the State, and broadening its cooperation with other agencies involved in air pollution research and other work, as listed in this report.
2. Enact appropriate legislation to develop a State air pollution program to protect the State's air resources. In this connection, the following principles are suggested for review and consideration:
    - (a) State legislation should be designed to permit orderly development of the program of the State agency designated to carry out its provisions. The legislation must provide the basis for establishing the organizational unit in the State agency and for recruiting competent personnel to staff this unit. It also must provide the means for obtaining technical equipment and for maintaining a laboratory to provide necessary services.
    - (b) The legislation should provide the basis upon which the State agency can plan a comprehensive program, taking into account the varying requirements of the different areas in the State.
    - (c) The State agency should be authorized to collect and disseminate information relating to air pollution, its prevention and control.
    - (d) The State agency should have the authority to engage in research programs directed toward the solution of the air pollution problems occurring in the State.
    - (e) The State agency should have the authority and facilities to conduct studies and investigations relating to air pollution as it may deem advisable and necessary, or as specifically requested by local and regional control organizations.
    - (f) The State agency should be authorized to develop and maintain a system of monitoring the State's atmosphere for the purposes of determining the presence and quantity of air pollutants.
    - (g) The State agency should be authorized to provide technical assistance and cooperation to local and regional control programs.
    - (h) The State agency should have the authority to provide the necessary services in those areas of the State where there is no local staff but where there is need for attention.
    - (i) The State legislation should make clear that all causes and effects of air pollution are included within the areas of responsibility of the State agency; in addition to health effects these would include the harmful effects on plant and animal life, on visibility as it affects air and surface transportation, and on property.
3. Consider the need for enabling legislation to provide for jurisdictional areas or districts not necessarily the same as existing political jurisdictions for air pollution control purposes.
4. In line with any legislative program, designate an agency to represent the State in interstate and Federal air pollution matters. This agency should be authorized to accept and administer grants from the Federal government and other sources, public or private, for carrying out any of the functions listed above.

INTRODUCTION

Defining the Subject

It is difficult to define "community air pollution" in words acceptable to everyone. Some state that it is the addition of any foreign matter to "pure air;" this is somewhat severe and vague. There are a number of various definitions used for air pollution by various states and other agencies. A definition used by the Federal Ad Hoc Interdepartmental Committee on Community Air Pollution is, in part, as follows:

> Community air pollution is the presence in the ambient atmosphere of substances put there by the activities of man in concentrations sufficient to interfere directly or indirectly with his comfort, safety or health, or with the full use and enjoyment of his property.

For an air pollution problem to exist, three factors must be present: a source of pollutants, a susceptible population or other receptor, and a means of transport between the two (a mechanism which is controlled by topography and weather).

Community air pollution arises from many of the activities of man. Consequently, such factors as population density, industrial activity, modes of transportation, fuel usage practices, waste disposal practices and other human activities individually or collectively play important roles. In addition, such natural features as meteorology and topography are important since they can strongly affect the accumulation or dispersion of air-borne pollutants, possibly increasing their undesirable effects.

Determination of the existence of air pollution problems is not always based solely on known or suspected adverse effects on health, comfort, safety or economics; public opinion is often the criterion. Nevertheless, it is the responsibility of official agencies to point out unsatisfactory conditions, actual or potential, when such are not obvious to the public (for example, the presence of nuclear radiations), so that suitable community action will develop.

Origin of the Study

Governor Price Daniel indicated his understanding of the potential health hazards of polluted air when he issued an Official Memorandum[1] which, in part, asked all Texas citizens to cooperate actively with the State Department of Health in arousing public attention in the fight against air pollution. The State Commissioner of Health, Doctor Henry A. Holle, visualizing a potentially increasing problem in Texas, assigned to the new Division of Occupational Health responsibility for a program to prevent and control community air pollution. This appraisal is one important result of the widespread interest and concern expressed by private citizens, public groups, municipal authorities and state agencies toward the problem of air pollution.

The Texas State Department of Health, realizing the need for action, requested the assistance of the United States Public Health Service in conducting an appraisal of the air pollution situation throughout the State.* Negotiations for this assistance were completed in October, 1957, and the work was officially initiated December 1, 1957.

Purpose

The intent of this joint appraisal was to:

1) Determine the status of current air pollution problems and bring into proper perspective the overall situation.

2) Evaluate those factors which have a direct

---

*The 84th Congress, by Public Law 159, made available support for air pollution research, training, demonstration projects and technical assistance to states and their subdivisions through a program administered by the United States Public Health Service.

or indirect bearing on either the present or the potential air pollution problem.

3) Recommend the necessary action which should be taken, on a state or local level, in order to provide and maintain a healthful and comfortable air environment.

Methodology

The scope of a statewide appraisal of this nature could range anywhere from a brief reconnaissance based on visual observations to a detailed study, including local field air sampling and analysis, extending over a period of several years.[2] The methodology employed in this appraisal was intermediate between these two approaches in that it did not include air sampling and analysis but did exploit to the fullest degree all of the existent data in the State relevant to the air pollution problems and developed new data by interview and questionnaire. In planning and organizing this appraisal, the experience of engineers, who had conducted similar studies in other states, was of material assistance.

The data used in preparing this report were obtained by:

1) Interview with informed individuals
2) Questionnaire to health officers and industries
3) Direct observation
4) Review of existing data

Field visits were made to all cities in the State with over 10,000 population (according to the 1950 census of population) for personal interviews with the local health officer and other informed individuals. In each community visited, the first contact was with the local director of health. Thereafter, available information was obtained from city managers, mayors, city engineers, building, planning and zoning departments, fuel dealers, U. S. Weather Bureau personnel, universities, associations, and other governmental agencies.

The 71 cities visited contained approximately 48 percent of the 1950 State population of 7,711,194[3] and about 56 percent of the estimated 1957 population of 9,140,000.[4] Visits were made to county health units if they were located in or near the cities visited. Sixty-two counties of the 254 in the State were visited. The 1950 population included in the combined jurisdiction of county and city health departments visited was 5,478,232, or 71 percent of the total State population.

To obtain information relative to air pollution problems in those areas not visited, a questionnaire was prepared and mailed to the local city and county health officers. This questionnaire was designed to elicit the opinions of local officials relative to the existence of air pollution problems, the type, source and effect of the pollution, and any local activity or control measures being used. One hundred eighty-two counties were covered solely by response to questionnaires. The population of these 182 counties in 1950 was 2,190,125 or 28.4 percent of the State total. These questionnaires were mailed to 446 city and county health officers and 410 replied for a 92 percent response. Only 36 health officers failed to respond. There were ten counties which were neither visited nor contacted by questionnaires since no health officer was available. These ten counties had a combined population of 42,837 or only about one-half of one percent of the State total. The type of coverage utilized to collect information is shown by counties in Figure 1.

An industrial questionnaire was prepared and mailed to all industries in the State employing 100 or more persons. This questionnaire was designed to give information as to 1) the location, size and general type of the industry and 2) the programs of the industry regarding air pollution controls and activity. The response varied somewhat according to the type of industry, but out of a total of 974 questionnaires mailed, 543 were returned, giving a response of 55.7 percent.

Copies of each of the questionaires and cover letters used in this appraisal are shown in Appendix A.

Direct observations were made of the existing conditions during each field visit. However, this source of information was used only to supplement the evidence and opinions of the local health officer. It was realized that an opinion formed from a brief visit could very easily be erroneous.

A review of the data from previous studies was made to determine the areas in which work had been done and to indicate the fields which were currently receiving the attention of investigators.

TYPE OF CONTACT, BY COUNTIES, FOR COLLECTING INFORMATION

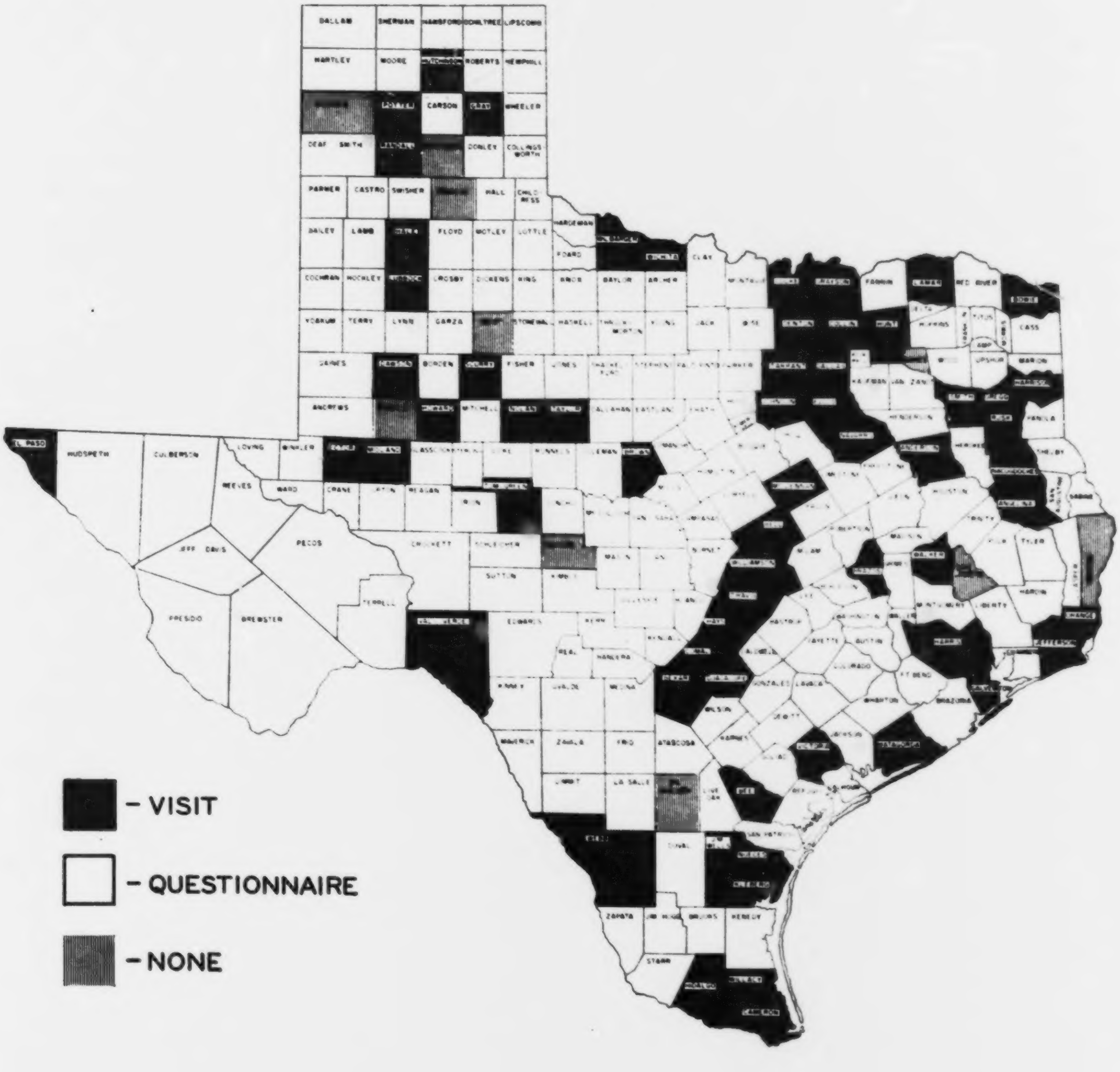

DALLAM
SHERMAN
HANSFORD
OCHILTREE
LIPSCOMB
HARTLEY
MOORE
ROBERTS
HEMPHILL
CARSON
WHEELER
DEAF SMITH
DONLEY
COLLINGSWORTH
PARMER
CASTRO
SWISHER
HALL
CHILDRESS
HARDEMAN
BAILEY
LAMB
FLOYD
MOTLEY
COTTLE
FOARD
CLAY
COCHRAN
HOCKLEY
CROSBY
DICKENS
KING
KNOX
BAYLOR
ARCHER
MONTAGUE
FANNIN
RED RIVER
YOAKUM
TERRY
LYNN
GARZA
STONEWALL
HASKELL
THROCKMORTON
YOUNG
JACK
WISE
HOPKINS
TITUS
CASS
GAINES
BORDEN
FISHER
JONES
SHACKELFORD
STEPHENS
PALO PINTO
PARKER
UPSHUR
MARION
ANDREWS
MITCHELL
CALLAHAN
EASTLAND
KAUFMAN
VAN ZANDT
HENDERSON
PANOLA
EL PASO
HUDSPETH
CULBERSON
LOVING
WINKLER
RUNNELS
SHELBY
REEVES
WARD
CRANE
REAGAN
HOUSTON
SABINE
JEFF DAVIS
PECOS
CROCKETT
SCHLEICHER
TRINITY
POLK
TYLER
SUTTON
MASON
BURNET
MILAM
WALKER
PRESIDIO
BREWSTER
TERRELL
EDWARDS
KERR
MONTGOMERY
LIBERTY
HARDIN
REAL
BANDERA
FAYETTE
AUSTIN
KINNEY
UVALDE
MEDINA
GONZALES
LAVACA
COLORADO
FT. BEND
BRAZORIA
WHARTON
MAVERICK
ZAVALA
FRIO
ATASCOSA
KARNES
JACKSON
LA SALLE
LIVE OAK
REFUGIO
SAN PATRICIO
DUVAL
ZAPATA
JIM HOGG
BROOKS
KENEDY
STARR
CAMERON
- VISIT
- QUESTIONNAIRE
- NONE

FIGURE 1

FINDINGS

Population

The 1958 population of Texas is estimated at 9,320,000, an increase of 17.3 percent since the 1950 census. Ranked sixth in the Nation in population, Texas' gain of population between the 1940 and 1950 census was 20.2 percent, or 1,296,370 persons—the third largest state gain in the Nation. Predicted population figures indicate a continued large growth, reaching 9,724,000 in 1960, and 11,752,000 by 1970.[4] (Figure 2.)

In 1950, with a population of 7,711,194, 62.7 percent lived in urban areas. Over the years, this figure has been constantly rising. (Table 1.)

TABLE I

GROWTH OF URBAN POPULATION[3]

YEAR	% URBAN POPULATION
1920	32.4
1930	41.0
1940	45.4
1950	62.7

The growth of urban areas was slowed by the depression of the '30's but greatly accelerated in the war years. It is expected that the movement of people to the cities will continue at a high rate over the coming years. A comparison of Figure 3, which shows population distribution by county, and Figure 4, which shows increase in population from 1940 to 1950 by counties, indicates that those counties with the largest population also have the largest increase in population.

There are seven cities in the State with over 100,000 population. (Table 2.) These cities account for 27 percent of the total State population (1950). The 15 standard metropolitan areas in the State contain almost one-third of the State's population. The 15 major metropolitan areas are: Houston, Dallas, San Antonio, Fort Worth, Beaumont-Port Arthur, El Paso, Austin, Corpus Christi, Waco, Lubbock, Amarillo, Galveston, Wichita Falls, San Angelo, Laredo.

TABLE 2

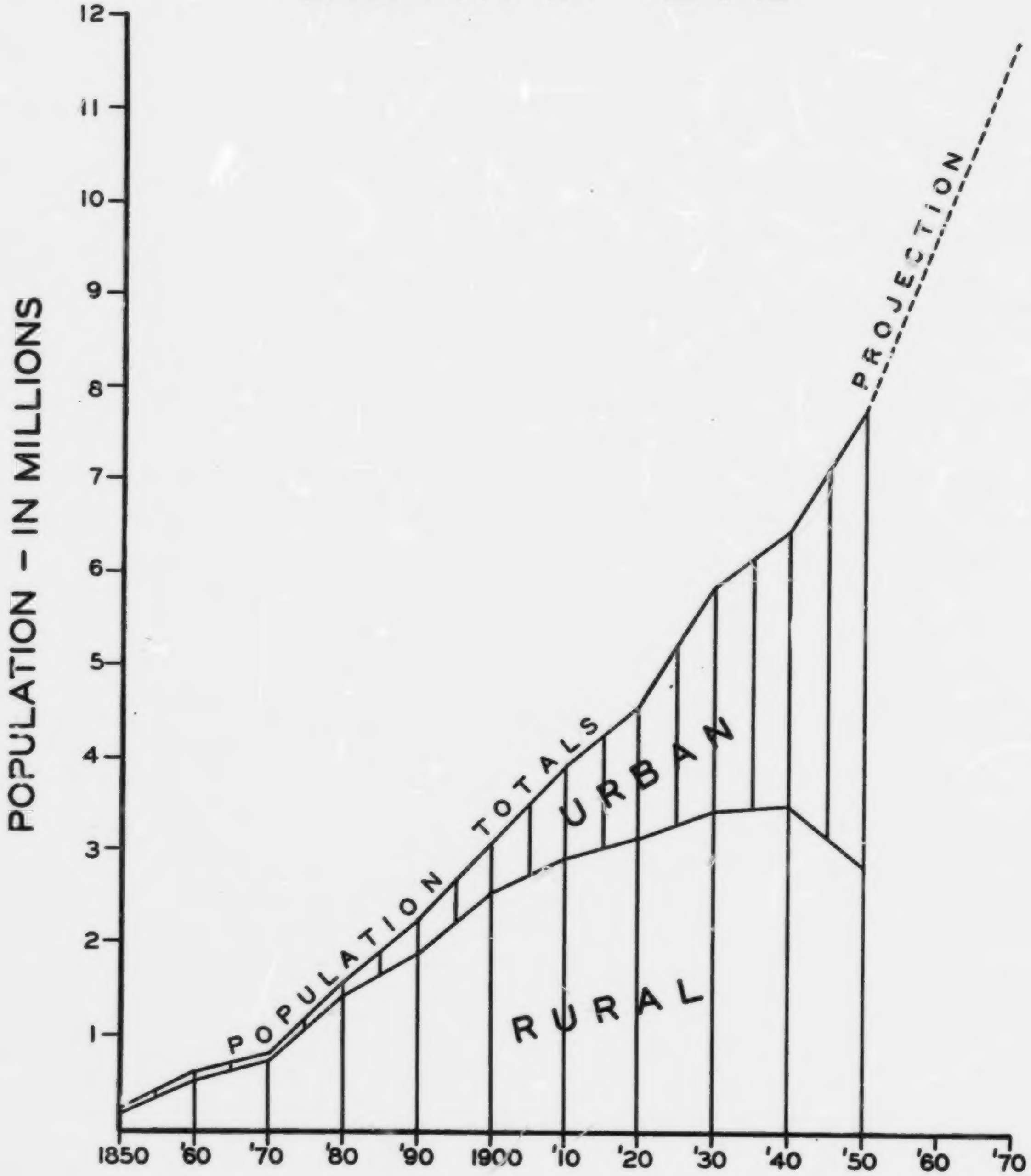
POPULATION IN GROUPS OF PLACES, 1950[3]

Size of Place	Number of Places	Population
100,000 or More	7	2,089,076
50,000-100,000	9	620,856
25,000- 50,000	5	175,565
10,000- 25,000	50	806,434
5,000- 10,000	80	558,229
2,500- 5,000	121	417,269
Under 2,500	13	18,296
Other Urban	......	152,334
Total Urban	285	4,838,061
1,000- 2,500	228	361,654
Under 1,000	253	138,920
Other Rural	......	2,372,560
Total Rural	481	2,873,134

The population picture reveals two significant facts:

1) the State is growing at a great rate, and
2) the State is becoming more "urbanized;" those areas of the State with heavy concentrations of people show the greatest increase in population.

With an expanding population and an "urbanization" of that population, the air over our communities will be called on to receive more and more wastes. Since the air resource over a given



URBAN AND RURAL POPULATION GROWTH IN TEXAS

FIGURE 2

AVERAGE POPULATION PER SQUARE MILE OF TEXAS COUNTIES - 1950

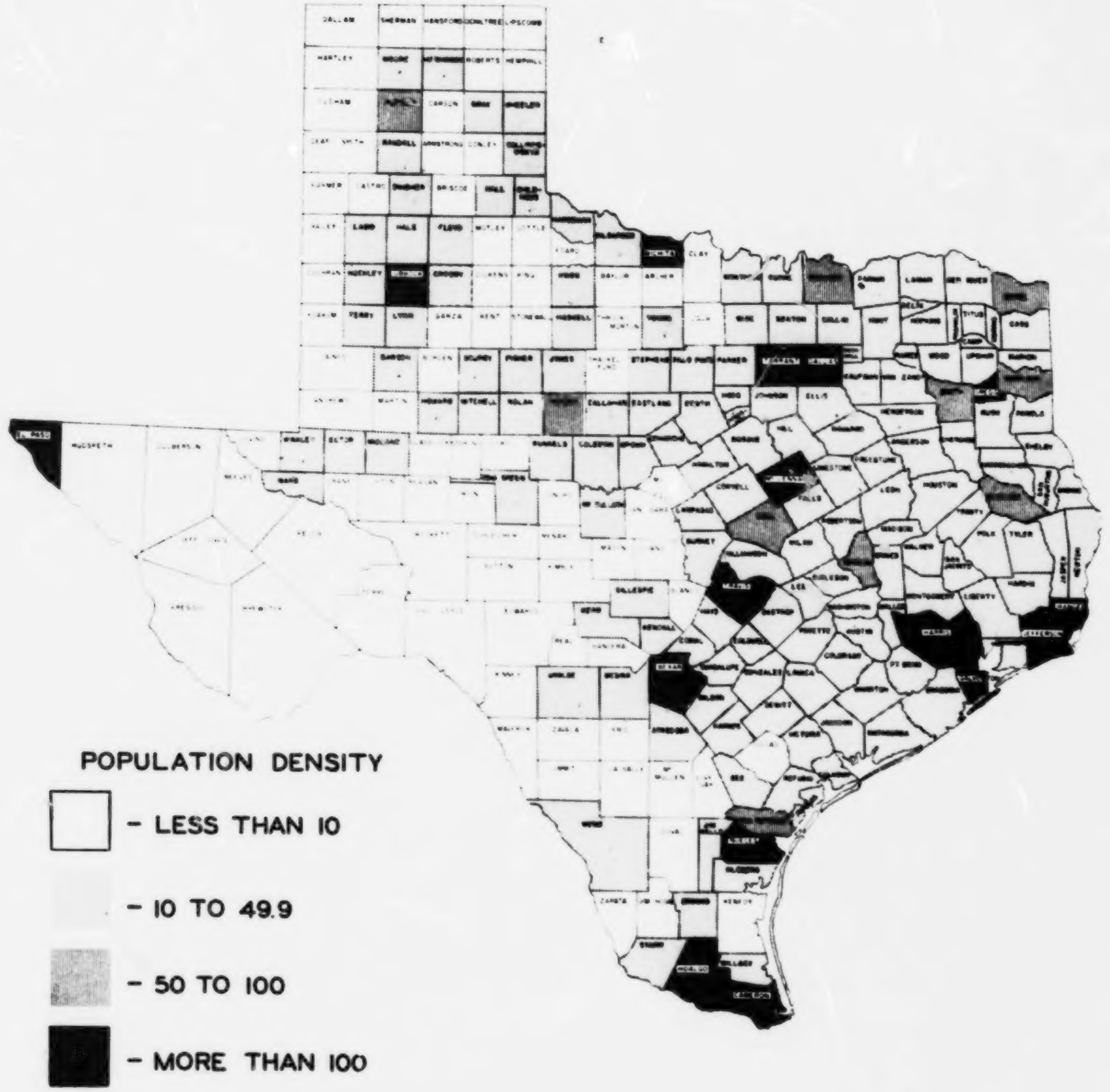
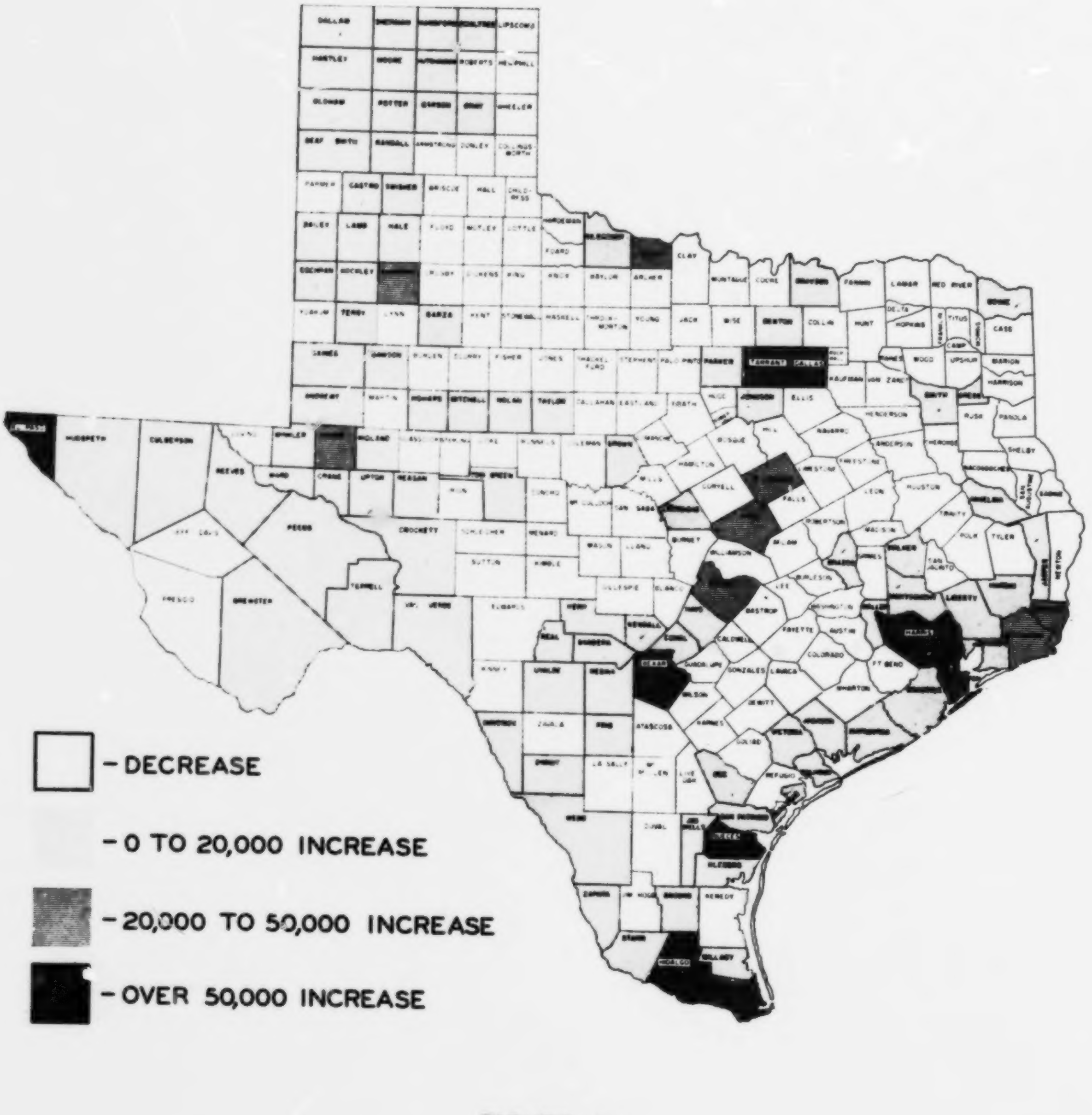

POPULATION DENSITY
☐ - LESS THAN 10
- 10 TO 49.9
▨ - 50 TO 100
■ - MORE THAN 100

FIGURE 3

CHANGES IN THE POPULATION OF TEXAS COUNTIES 1940 – 1950



- DECREASE
- 0 TO 20,000 INCREASE
- 20,000 TO 50,000 INCREASE
- OVER 50,000 INCREASE
TARRANT
DALLAS
HARRIS
BEXAR
HIDALGO

FIGURE 4

area remains constant and is a limited quantity, as communities increase in population and as industrial activity increases, air pollution and the need for appropriate control measures will undoubtedly grow.

Sources of Pollution

Fuel Usage

The combustion of fuel (Table 3) for space and water heating, for power generation, in industry and in transportation releases large quantities of pollutants to the atmosphere in the form of gases, solid particles, and liquid droplets. The amount and type of pollutants are affected by type of fuel, type and condition of firing equipment, load demands, firing practice, and use of collection devices. Texas, by virtue of its natural gas and oil, uses very little solid fuel. These fuels, although not ordinarily associated with the emission of visible smoke and fly-ash, are responsible for emission of large quantities of pollutants to the atmosphere, which must be given due consideration in the larger urbanized areas of the State (Appendix B).

Use of natural gas: Use of natural gas in Texas amounted to 466,900,688,000 cubic feet in 1956 (Table 4).

TABLE 3

FUEL CONSUMPTION IN TEXAS—1955[5, 6, 7, 8]

FUEL	AMOUNT	APPROXIMATE TRILLIONS OF B. T. U. (a)	PERCENT B. T. U.
Natural Gas	443,597,245 M. C. F.	454	53
Fuel Oil	58,836,000 Bbls. (42 gal.)	367	43
Kerosene	3,986,000 Bbls. (42 gal.)	23	3
Coal (b)	410,000 Tons	9	1
L.P. Gas (c)	693,596 Gallons	Negligible	0

(a) Assuming 100 percent efficiency in combustion.

(b) Industrial consumption for 1954; in 1950, 30,000 tons of coal were used for home heating, a negligible amount; railroads and electric utilities used no coal in 1955. In the four state area of Arkansas, Louisiana, Oklahoma and Texas, 2,674,000 tons of coal (61 trillion B. T. U.) were used in 1955.

(c) Liquefied petroleum gas, 73 billion B. T. U. usage.

TABLE 4

USE OF NATURAL GAS—1956[5]

USER	THOUSANDS OF CUBIC FEET	PERCENT OF TOTAL	PERCENT INCREASE OVER 1950
Domestic	116,281,095	24.9	57.4
Commercial	39,438,579	8.4	29.2
Industrial (a)	287,081,547	61.5	100.7
Other	24,099,467	5.2	119.9
TOTAL	466,900,688	100.0	80.6

(a) Including usage by electric utilities for generating power.

TABLE 5

USE OF NATURAL GAS BY YEARS[5]

	1950	1951	1952	1953	1954	1955	1956
Total gas consumption in billions of cubic feet	258.4	303.5	382.4	395.3	400.8	443.6	466.9

The use of natural gas has been increasing steadily (Table 5) and is expected to continue to increase.

No problems due to gas combustion were noted in this survey. Yet, in the large urban areas of the State, consideration should be taken of the contribution of the products of gas combustion (aldehydes, oxides of nitrogen, organic acids, and other organics) to the over-all pollution load of the atmosphere.

Fuel oil usage: A total of 58,836,000 barrels of fuel oil were used in the State in 1955. This was an increase of 3,611,000 barrels over 1954 (Table 6).

TABLE 6

USE OF FUEL OIL—1955[6]

(Thousands of 42 gallon barrels)

USER	DISTILLATE	RESIDUAL	TOTAL	PERCENT OF TOTAL
Railroads	6,180	1,581	7,761	13.1
Vessels	2,761	25,718	28,479	48.2
Power Plants	74	17	91	0.2
Industrial	971	1,843	2,814	4.8
Oil Company Use	2,295	4,057	6,352	10.7
Heating Oils	1,335	1,275	2,610	4.4
Military	3,253	2,969	6,482	11.0
Miscellaneous	3,513	648	4,161	7.1
Range Oil	347	....	347	0.5
TOTAL	20,728	38,108	58,836	100.0

TABLE 7

SHIPS AND TONNAGE FOR GULF PORTS—1956[9]

PORT	NUMBER OF SHIPS			TONNAGE
	Dry Cargo	Tankers	Total	
Houston	3,972	3,577	7,549	52,293,262
Port Arthur	1,436	4,610	6,046	24,832,926
Galveston	3,961	360	4,321	6,958,214
Corpus Christi	1,780	1,357	3,137	15,568,864
Port Aransas	706	2,103	2,809	9,800,758
Beaumont	469	2,253	2,722	25,731,843
Texas City	202	1,171	1,373	14,798,944
Others (a)	858	578	1,436	8,652,568

(a) Brownsville, Freeport, Orange, Port Isabel.

Almost half of the fuel oil used was consumed by vessels. In 1956, the 11 Gulf Ports (Table 7) handled 29,393 ships with a total tonnage of 158,637,379.

No instances of complaints concerning vessel smoke were found in this survey. The contribution of vessels to the over-all pollution load of the coastal cities is considered minor.

The remaining fuel oil usage is about equally divided among railroads, oil company use, military and all others, including industry and heating. The 57 railroad companies in Texas used 99.76 percent fuel oil, 0.01 percent gasoline and 0.24 percent other combustibles for fuel in 1956.[10] Railroad fuel usage amounted to 1,286,401 equivalent tons of coal. As with vessels, no complaints concerning railroad smoke were found in this survey, but a contribution of diesels to the over-all pollution of larger urbanized areas, though not of major proportions, was evident.

The combustion of fuel oil releases aldehydes, oxides of nitrogen, sulfur oxides, organic acids and other organics to the atmosphere. (Appendix B). In addition to fuel oil, 3,903,000 barrels of kerosene (41 percent used as range oil), and 14,556,000 barrels of jet fuel were used in 1955.

Liquefied petroleum gas: The use of liquefied petroleum gas in Texas amounted to 1,834,786,000 gallons in 1955, an increase of 22.4 percent over 1954 (Table 8).

Of this total amount, 23.3 percent was butane, 28.9 percent was propane, and 47.8 percent was a mixture of the two. The combustion of liquefied petroleum gases creates combustion products similar to those of natural gas.

Solid fuel: The use of coal as a fuel in Texas is practically non-existent. Although no use data are available for Texas separately, in the four-state area of Arkansas, Louisiana, Oklahoma and

TABLE 8

USE OF LIQUEFIED PETROLEUM GASES—1955[7]

USER	AMOUNT IN THOUSANDS OF GALLONS	PERCENT OF TOTAL
For Fuel:		
Domestic and Commercial	385,567	21.0
Internal Combustion	302,019	16.5
All Others	6,010	0.3
TOTAL FUEL	693,596	37.8
As Non-Fuel:		
Gas Manufacturing	5,555	0.3
Industrial	105,030	5.7
Synthetic Rubber	347,579	18.9
Chemical	683,026	37.3
TOTAL NON-FUEL	1,141,190	62.2

Texas only 2,674,000 tons of bituminous coal were consumed in 1955.[8] Of this amount 297,000 tons were used by coke and gas plants, 114,000 tons were sold by retail dealers (for residential heating and others) and 2,263,000 tons were used in other means. No coal was used at electric generating stations. Only one power plant, a private industrial plant at Rockdale, is known to burn lignite. The primary use of solid fuel is in those industrial processes where it is used as a reactant, as in an electro-metallurgical furnace. No problems concerning the use of coal were found in this study, and its contribution to the over-all air pollution problem is considered minor.

Generation of electricity: In Texas in 1955, the 53 steam-electric utility plants consumed only natural gas as fuel.[11] This amounted to 265,734,000,000 cubic feet. Of these plants, 30 are designed for gas usage, and 23 for gas with standby oil usage. Since the cost per million B.T.U. consumed was 10.4 cents for gas, as compared to 47.8 cents for oil, standby oil usage amounted to only 15 to 90 thousand barrels. The continually increasing cost of natural gas may force the steam-electric utilities to increase the use of fuel oil. In 1956, there were 173 electric power plants in Texas of which 60, powered by steam, had a total capacity of 5,960,508 kilowatts; 93 powered by internal combustion engines, had a total capacity of 192,364 kilowatts; and 20 hydro-electric plants had a total capacity of 410,030 kilowatts.[10] No problems concerning the use of fuel in the steam-electric plants was found in this study. The exclusive use of natural gas minimizes the fly-ash and sulfur dioxide problems of the coal-fired or oil-fired plants.

TABLE 9

FUEL USED FOR RESIDENTIAL HEATING—1950[12]

FUEL	PERCENT OF HOMES HEATED BY GIVEN FUEL			
	Statewide	Urban	Rural Non-Farm	Rural Farm
Gas*	75.5	87.1	65.1	41.5
Wood	11.5	3.7	17.0	37.2
Liquid	7.4	4.6	11.3	14.2
Coal	0.7	0.6	0.9	1.2
Electric	0.5	0.4	0.8	0.9
Other	1.4	1.1	2.1	2.4
Not Reported	0.4	0.4	0.3	0.2
Not Heated	2.3	2.2	2.4	2.3

*Includes bottled gas.

Residential Fuel Usage: In 1950, natural gas was the most popular residential fuel, accounting for three-quarters of residential heating. This was followed by wood and fuel oil (Table 9).

Little coal was used for heating purposes. No complaints regarding residential fuel usage were found in this survey. Heating loads vary greatly in Texas. The number of annual degree-days (Tables 10 and 11) vary from 617 at Brownsville in the Southern tip of the State to 4345 at Amarillo in the Northern Panhandle area; and from 1517 at Port Arthur in the East to 2641 at El Paso in the West. A degree-day is the number of degrees that the average temperature for that day is less than 65°. For example, if the average temperature for a day was 50°, then that day is said to be a 15 degree-day.

Industrial fuel usage: The manufacturing industries used a more varied type of fuel than the residential and other users of fuel (Table 12). The five-fold increase in coal usage between 1947 and 1954 is noteworthy.

Summary: Texas, with its great use of natural gas and negligible coal usage, does not have the problem of smoke, fly-ash and sulfur dioxide generally associated with coal and oil burning areas. This "clean" fuel does not present any problem of air pollution concern in rural areas and smaller cities, but its contribution to the community-wide problem in the large urbanized areas of the State must be considered.

Pollution from Motor Vehicles: The role of motor vehicle exhausts in air pollution is of increasing concern in large communities throughout the country. These vehicles emit significant quantities of hydrocarbons and nitrogen oxides and relatively smaller amounts of aerosols, oxides of sulfur, aldehydes, ammonia, organic acids and other organic compounds. Other pollutants result from the use of additives to gasoline, such as tetraethyl lead, boron, phosphorous compounds and detergents; and from motor oils and their additives. (Appendix B.)

In 1956, there were 4,220,147 motor vehicles registered in the State—one vehicle for every 2.1 persons.[10] (The national average is one for every 3.4 persons.) These motor vehicles used 4,359,317,500 gallons of gasoline, some 12,000,000 gallons per day.

The number of motor vehicles in the State and the amount of gasoline consumed have been rising at a great rate since the end of World War II. (Figure 5.)

Meteorological and physiographic conditions have favored Texas as a site for military air training installations. As of September 1957, there were 25 major U. S. Air Force Bases in Texas out of a total of 150 in the United States.[10] Also, there are six domestic trunk air lines serving 44 airports in the State. The use of fuel by these planes is large in quantity, but the over-

TABLE 10

NORMAL ANNUAL DEGREE-DAYS FOR TEXAS CITIES[13]

CITY	DEGREE-DAYS
Brownsville	617
Laredo	718
Corpus Christi	924
Houston	1276
Del Rio	1407
Port Arthur	1517
San Antonio	1579
Austin	1713
Waco	2025
Dallas	2272
Texarkana	2362
Midland	2565
El Paso	2641
Abilene	2657
Wichita Falls	3025
Lubbock	3587
Amarillo	4345

TABLE 11

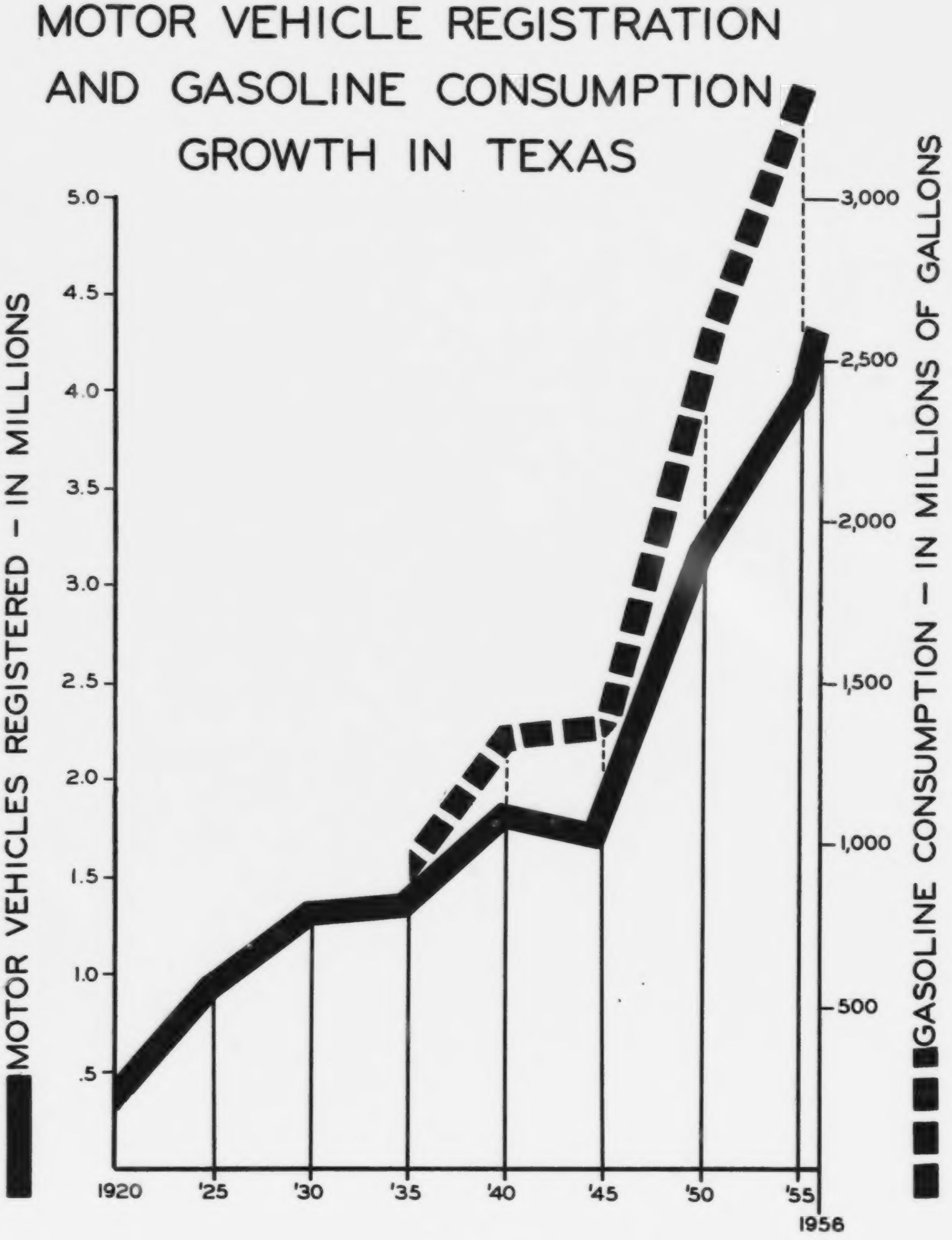
NORMAL DEGREE-DAYS BY MONTHS[13]

MONTH	BROWNSVILLE	AUSTIN	AMARILLO
January	219	484	921
February	106	322	711
March	74	211	586
April	0	50	298
May	0	0	99
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	37
October	0	30	240
November	59	214	594
December	156	402	859
Year	617	1713	4345

TABLE 12

FUEL AND ELECTRIC ENERGY USED IN THE MANUFACTURING INDUSTRY FOR TEXAS[14]

FUEL	1954		1947	
	Amount	Potential Energy Trillions of B. T. U.	Amount	Potential Energy Trillions of B. T. U.
Coal	410,000 Tons	10	80,000 Tons	2
Coke	432,000 Tons	9	252,000 Tons	5.3
Fuel Oil	734,000 Bbls.	4.5	1,104,000 Bbls.	7
Gas	750,917 M. C. F.	0.8	363,054 M. C. F.	0.4
Electric Power				
Purchased	7,682 million KWH	26.2	2,371 million KWH	8.1
Generated	10,733 million KWH	36.7	2,657 million KWH	9.0



MOTOR VEHICLE REGISTRATION AND GASOLINE CONSUMPTION GROWTH IN TEXAS

FIGURE 5

all contribution to the air pollution load of any given area is considered minor due to the continuing movement.

The concentration of population in metropolitan areas is accompanied by a concentration of motor vehicles and an intensification of problems associated with vehicle exhausts. (Table 13.) While the specific over-all effect of emissions from vehicle exhausts is impossible to estimate within the scope of this study, cognizance should be taken of their substantial contribution to the over-all pollution load of the urban atmosphere and to their increasingly important role as a pollution source as population and traffic increases. The odor from diesel bus exhausts is a frequent cause for complaint.

Industrial Activity

Texas, in recent years, has been changing from a highly agricultural-rural economy to a more industrialized-urban one. In 1940, the agricultural employment in the State totaled 639,226, while manufacturing employment totaled 210,631; by

TABLE 13

MOTOR VEHICLE REGISTRATIONS—1956*[15]

COUNTY	MAJOR CITIES	MOTOR VEHICLE REGISTRATION
Harris	Houston	511,198
Dallas	Dallas	404,086
Tarrant	Fort Worth	246,417
Bexar	San Antonio	245,255
Jefferson	Beaumont - Port Arthur	107,929
El Paso	El Paso	98,308
Nueces	Corpus Christi	93,988
Travis	Austin	77,061
Lubbock	Lubbock	66,420
McLennan	Waco	64,009
Wichita	Wichita Falls	58,326
Hidalgo	Edinburg and Others	54,341
Galveston	Galveston - Texas City	53,797
Potter	Amarillo	52,766

*Counties with over 50,000 registration

1950, agricultural employment had declined to 442,341, while manufacturing employment had risen to 372,909.[19, 25] (Table 14.) The 1954 census showed manufacturing employment at 410,364. The 1956 estimate of the Texas Employment Commission was 524,195.[16]

In 1952, the value added by manufacturing was $3,206,103,000, as compared by $2,833,495,000 for agriculture.[17] The gap between the two is widening, however, as manufacturing continues to grow, while agriculture remains fairly stable.

The manufacturing economy owes much of its growth to the abundant reserve of mineral products in the State, which in themselves produce a greater annual value than agricultural products. The emphasis of the industrial economy is therefore based upon the processing of these minerals.

Agricultural industry: Cotton is, by far, the State's leading acreage and money crop. (Figure 6.) In 1956, the crop value of cotton was $548,554,000 or 48.1 percent of the combined crop value for the State.[10] The latest U. S. Census reports for 1954 show that approximately one-fourth of all the State cropland harvested was in cotton. In both the production and ginning of cotton, Texas ranks first in the nation, accounting for about 27 percent of the United States total.[20] In 1956, Texas produced 3,538,376 running bales of cotton, while the total grown in the United States was 13,151,208 running bales. In the same year Texas ginned 3,631,455 equivalent bales as compared to 13,309,827 for the United States total.

The full significance of the high cotton-ginning activity is realized when one considers that up to 1,000 pounds of waste (burs, moats, trash and lint) may be produced for each bale of cotton ginned.[21] Lately, the advent of machine-picked cotton has served to increase the volume of waste above that from cotton picked by hand.

Other factors have added to the difficulty of cleaning the effluent before its discharge to the atmosphere. Modern gins now use pneumatic conveying equipment instead of screw conveyors and air-blast cleaning equipment rather than brushes. These process changes have increased the ginning rates, but, at the same time, have also increased greatly the volumes of lint and dust-laden discharge air.

A few years ago, the U. S. Department of Agriculture prescribed requirements for the disposal of cotton burs to help control the pink bollworm. Alternate methods of disposal of burs were listed but, incineration was recommended. Most gin operators have chosen incineration. Incineration of burs creates a problem. They cannot be burned on the ground or in pits, since poor combustion results in great amounts of smoke. Jug-type incinerators are an improvement over open burning but still create a smoke problem. This is the type most frequently used by gin operators throughout the State. Good combustion is obtainable from specially designed incinerators with primary and secondary combustion chambers. Unfortunately, not many of these are in use in the State.

Air pollution problems associated with the ginning of cotton are some of the worst in the State. From the questionnaires received from health officers, the following was indicated: 107 officers had received complaints due to gins; 96 complaints concerned the smoke; 93 concerned lint and dust; and 19 concerned the odor of the burning burs. The effect of the pollutant as reported by the health officers was: discomfort of citizens 107; damage to property—21; damage to vegetation—11; damage to animal life—6.

Field visits to the 71 cities in the State with over 10,000 population revealed 23 cities (about one-third) with problems and complaints concerning the cotton gins. All 23 complained of dust and lint, but only 11 of these were troubled by smoke from burning burs. One instance was noted where odor was also a problem. The only reported effect of the pollutant was the discomfort of the citizens.

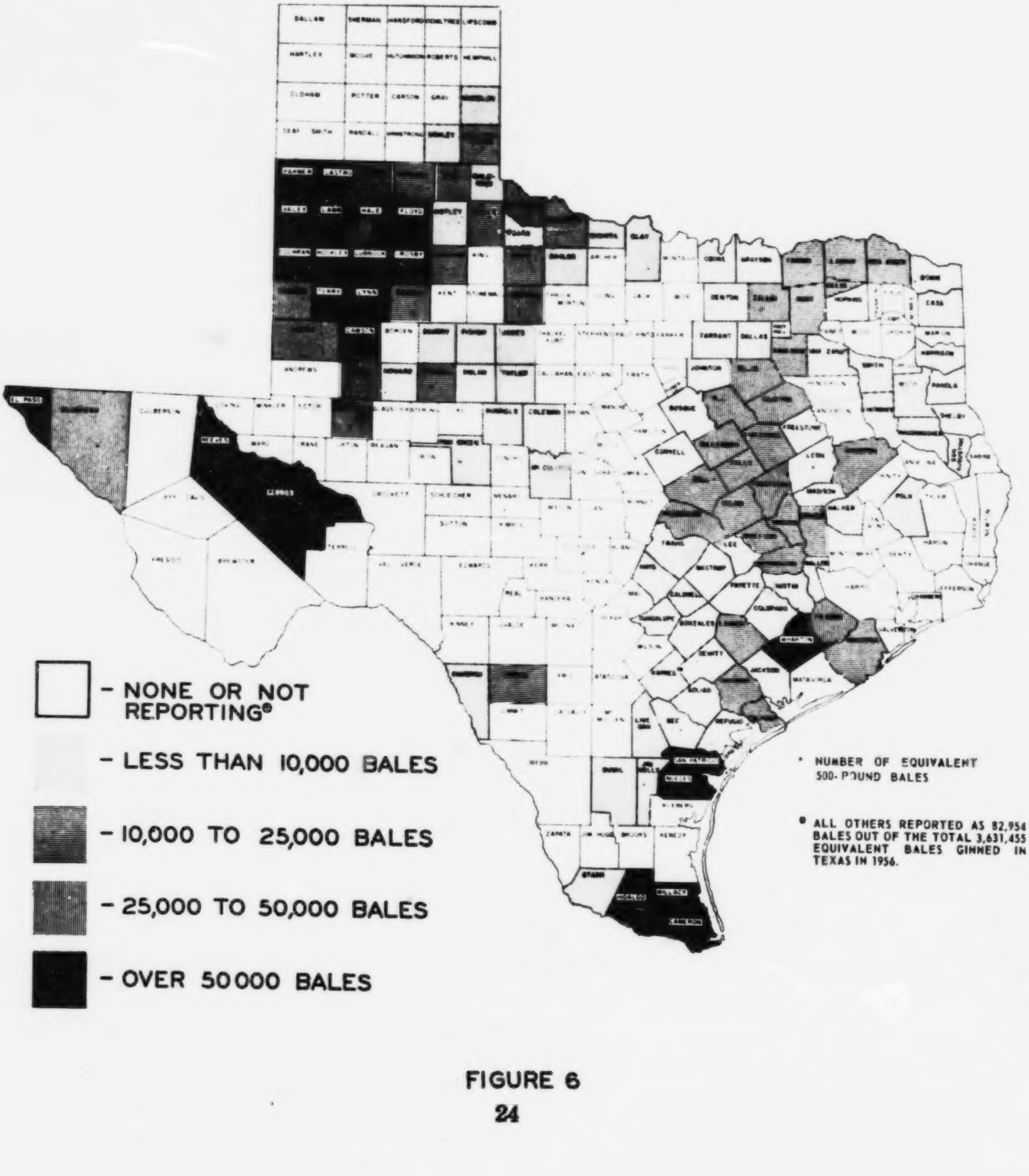
In many cases, lint had completely clogged the screens on doors and windows, thus preventing air circulation to the residents in the houses of the neighborhood. Many health officers (physicians) reported by personal communication or questionnaire that respiratory ailments of local residents were caused or aggravated by the dust from the ginning operation.

TABLE 14

EMPLOYMENT BY MAJOR INDUSTRIAL GROUPS—1950[18, 19]

INDUSTRIAL GROUPS	Texas Employees	Percentage of Employees		Ratio Texas/U.S.
		Texas	U. S.	
Agriculture, Forestry and Fisheries	445,939	16.2	12.5	1.30
Mining	89,911	3.3	1.6	2.06
Construction	236,276	8.6	6.1	1.41
Manufacturing - Total	372,909	13.5	25.9	0.52
Durable Goods	156,843	5.7	13.8	0.41
Non-Durable Goods	213,485	7.7	12.1	0.64
Non-Specified	2,581			
Transportation	227,170	8.2	7.8	1.05
Wholesale	590,224	21.4	18.8	1.14
Finance, Insurance and Real Estate	88,814	3.2	3.4	0.94
Business Services	72,498	2.6	2.5	1.04
Personal Services	230,317	8.4	6.2	1.36
Entertainment and Recreational Services	26,076	1.0	1.0	1.00
Professional Services	216,964	7.9	8.3	0.95
Public Administration	118,878	4.3	4.4	0.98
All Others	42,467	1.5	1.5	1.00
TOTAL	2,758,443			

BALES* OF COTTON GINNED BY COUNTIES — 1956


☐ - NONE OR NOT REPORTING®
- LESS THAN 10,000 BALES
- 10,000 TO 25,000 BALES
- 25,000 TO 50,000 BALES
■ - OVER 50000 BALES

* NUMBER OF EQUIVALENT 500-POUND BALES

® ALL OTHERS REPORTED AS 82,954 BALES OUT OF THE TOTAL 3,631,455 EQUIVALENT BALES GINNED IN TEXAS IN 1956.

FIGURE 6

Gin operators have quite a selection of control equipment from which to choose, much of which, however, is too costly for marginal operators. The cyclone collector will operate very well under surprisingly broad conditions; however, size and type must be carefully selected to avoid excessive pressure drop and still provide efficient collection of dust and lint.

Other agricultural problems causing discomfort to citizens were minor. As indicated by the questionnaires, dust from corn shelling operations were the source of three problems; alfalfa dehydration caused one problem. Crop dusting is a limited, yet very dangerous hazard. Three health officers indicated problems from the cause. As determined by the field visits, three cities previously had had problems with dusts and insecticides: poisonous arsenic compounds had caused fish kills in streams near a field being sprayed by planes; a number of transient farm laborers were suddenly taken ill when they entered a field too soon after the field had been sprayed; and a third case occurred when a mailman was accidentally dusted with insecticide. He was made extremely ill by the episode.

The State Legislature passed an act, effective September 1, 1953, to regulate, through powers granted the State Department of Agriculture, the sale, use and transportation of herbicides.[22] The Texas Department of Agriculture, in accordance therewith, has promulgated Herbicide Regulation Number 1 (Revised), effective date, March 18, 1958.[23]

Very few problems were associated with animals or poultry. Cattle pens were responsible for six odor problems and chicken pens, three odor problems in the areas contacted by questionnaires. Odor was obnoxious to the residents in the immediate area. Animal and poultry were the source of only three complaints in the cities visited. Again, odor was the chief complaint. To alleviate these situations, most cities either have nuisance regulations or operate under the State Nuisance Code.

Lumber industry: The pine-hardwood forests of East Texas, called the "Piney Woods," are the most important commercial timber area of the State. This area contains over 19 million acres, of which 62 percent or 12 million acres is classified as commercial timberland. Eighty-six percent of Texas' 412 sawmills were located within this area in 1956. Of these, 165 were stationary mills which produced 79 percent of the State's lumber.

The air pollution problems of this industry involved the disposal of sawdust and other wood wastes. Three cities visited had received complaints. One was caused by improper combustion of the waste, creating a smoke problem, and two others were caused by blowing sawdust. The questionnaires indicated that three areas were affected by smoke problems, and two of these were also bothered by sawdust. Discomfort of the citizens was the effect of the pollutant in all cases, but property damage was also claimed in two of these.

Mineral industry: The gigantic economy of Texas owes much to the abundant reserves in the State's storehouse of minerals. Since 1935, Texas has been the leading mineral producing State. Not only is it the leading state in total value of mineral production, it is first in the number of minerals produced and in the known minerals with potential value. A new record value of 4.2 billion dollars of mineral production in Texas was established in 1956.[24] Accounting for some 3.1 billion dollars (74 percent) of this total was crude oil. Texas oil fields produced a record 1.1 billion barrels of crude oil in 1956, and the gas fields yielded a record 5.1 billion cubic feet of natural gas. To supply this record flow of "black gold," the industry completed 24,764 new wells (nine percent more than 1955) and raised the State's total number of producing wells to 168,930. This drilling activity helped sustain the State's crude oil reserves at 14,783 million barrels, representing nearly 50 percent of the nation's total crude oil reserves. The crude oil production, by counties for 1956, is expressed graphically in Figure 7.[10]

As can be seen from Table 15, crude oil, natural gas and natural gas liquids constituted over 92 percent of the total mineral value added in 1956. However, the remaining mineral production is not small when compared to some other states. Sulfur is the most important of Texas minerals outside of the oil-gas group, as measured in value. Texas is one of the world's principal sulfur producing areas. Texas sulfur comes from two sources. It is

CRUDE OIL PRODUCTION IN TEXAS - 1956

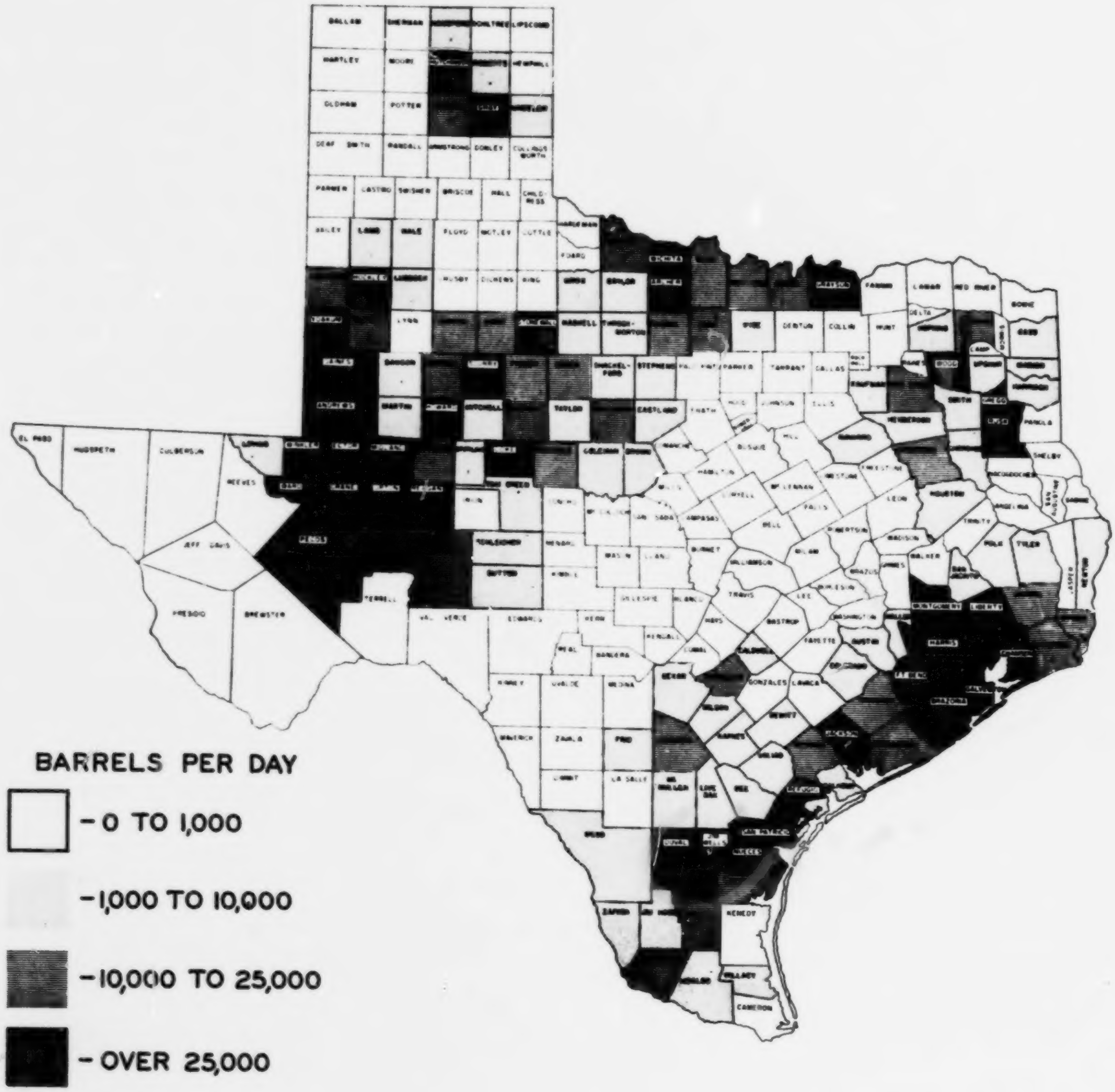

BARRELS PER DAY
- 0 TO 1,000
-1,000 TO 10,000
-10,000 TO 25,000
- OVER 25,000
DALLAM
SHERMAN
LIPSCOMB
HARTLEY
MOORE
OLDHAM
POTTER
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
PARMER
CASTRO
SWISHER
BRISCOE
HALL
CHILDRESS
BAILEY
LAMB
HALE
FLOYD
MOTLEY
COTTLE
LYNN
TAYLOR
EASTLAND
EL PASO
HUDSPETH
CULBERSON
REEVES
JEFF DAVIS
PRESIDIO
BREWSTER
TERRELL
VAL VERDE
DALLAS
TARRANT
DENTON
COLLIN
HUNT
FANNIN
LAMAR
RED RIVER
BOWIE
SHELBY
HOUSTON
HARRIS
BRAZORIA
KENEDY
WILLACY
CAMERON

FIGURE 7

TABLE 15

MINERAL PRODUCTION IN TEXAS—1956[24]

MINERAL	SHORT TONS (unless otherwise stated)	VALUE IN DOLLARS
State Total		4,197,640,000
Petroleum (crude)—thousand 42-gallon barrel	1,111,172	3,111,282,000
Natural Gas—million cubic feet	5,093,200	407,456,000
Natural Gas Liquids:		
Natural Gasoline and Cycle Products—thousand gallon	2,964,609	216,378,000
Liquified Petroleum Gases—thousand gallon	3,731,047	144,745,000
Sulfur:		
Frasch-process—long ton	3,437,061	91,026,388
Recovered Elemental—long ton	140,164	3,865,252
Cement	25,965,990	75,695,463
Sand and Gravel	29,335,697	27,212,554
Stone	32,772,827	36,349,747
Salt (common)	3,962,778	14,369,558
Lime	592,136	6,937,951
Clays	3,146,201	4,765,068
Gypsum	1,156,956	3,623,005
Helium (shipments)—cubic feet	145,830,220	2,364,325
Talc and Soapstone	41,332	244,368
Gem Stones	....	115,000
Undisclosed	....	62,347,838

found in great deposits at the top of some of the salt domes that lie beneath the surface of the earth along the Gulf Coast. It is also extracted from some of the mineral bearing gases found in the Panhandle, West Texas and on the Gulf Coast. Native sulfur was produced from salt dome formations during 1957 in Fort Bend, Harris, Brazoria, Liberty, Wharton and Jefferson Counties. Hydrogen sulfide emissions are associated with the mining of sulfur and have presented a problem in some areas.

Limestone and shales suitable for the production of Portland cement and other uses are found widely in the Blacklands, Grand Prairie, Edwards Plateau and the Trans-Pecos area. Along the Gulf Coast, oyster shell is used as a source of lime for cement production. There are cement plants in or near Houston, Dallas, San Antonio, Fort Worth, Waco, Corpus Christi and El Paso.

During the course of this appraisal, the following problems were reported from the production of minerals. Sour gas from crude oil production created a problem in five of the cities visited and four of those contacted by questionnaires. All nine caused discomfort to the local residents; five caused property damage; and two claimed damage to vegetation. Cycling plants producing butane and propane were reported to cause some odor problems in two cases. Cement plants were found to be creating six dust problems in the State. The predominant effect of dust was to cause discomfort to the citizens, but one case was reported to be damaging property and vegetation. Limestone and rock crushing operations created dust conditions that were a discomfort to residents in four separate instances. No air pollution problems were found to be associated with the remaining mineral industries.

Manufacturing industry: In many ways the economic development of Texas has been revolutionary in speed and character, but in nothing has it been greater than in the manufacturing industries. Texas produced $3,501,706,000 of manufactured goods in 1954.[25] This census figure was twice that of 1947, a doubling of the net value of manufactured products in seven years. It was more than seven times the figure of $448,523,000 in 1939, the last census before World War II.[10] In estimating what might be called the real increase, allowance must be made for inflation of values, but consideration must also be given to increased mechanization. As a practical estimate, the industrial production of Texas in 1954 was four times that of 1939, and it increased about 50 percent during the period of 1947 to 1954.[10]

Texas' industrial activity is varied, but the chemical industries now rank first, as measured by the net value of annual production. Next in order (according to the 1954 value added) the major industries are food and kindred products, petroleum and coal products, transportation equipment, machinery and primary metals. The importance of each of the industrial groups can be seen by examining Table 16. It may be seen that the chemical and petroleum industries together account for 34 percent of the total manufacturing value of the State.

Considering the industries according to the number of employees, food and kindred products rank first. The next four in decreasing order are transportation equipment, petroleum and coal products, chemicals and machinery.

Air pollution problems from the manufacturing industry encountered in this appraisal are geographically widespread and embrace many of the major manufacturing groups. (Table 17.)

1) **Food and kindred products:** The food industries are scattered widely over the State. Air pollution problems associated with the food industry include odors from slaughterhouses, rendering plants, milk and cheese processors and dust from grain milling and associated industries. Throughout the State, fifteen odor problems were associated with slaughterhouses and rendering plants; three odor problems from stockyards; six dust problems were associated with grain mills; and three other problems were created from miscellaneous other food industries.

2) **Chemical and allied products:** The great growth in chemical production has come from the development of industries associated with oil, gas and sulfur production. Most of the big chemical industries of Texas are located along the Gulf Coast. For example, according to the value added, Harris County alone produced over 26 percent of the State's chemicals in 1954.[25] Jefferson County, including Beaumont and Port Arthur, is also heavily engaged in chemical production. However,

TABLE 16

MANUFACTURING STATISTICS, 1947 AND 1954[25]

INDUSTRY	1954							1947	
	ESTABLISHMENTS		ALL EMPLOYEES		Value Added By Manufacture ($1,000)	Percent Of Total Value Added	Capital Expenditures, New ($1,000)	All Employees, Number	Value Added By Manufacture ($1,000)
	Total Number	20 or More Employees	Number	Payroll ($1,000)					
Chemicals and Products	522	229	36,976	179,926	722,056	20.6	141,176	23,552	234,496
Food and Kindred Products	1,921	644	67,862	226,314	533,060	15.2	28,914		
Petroleum and Coal Products	111	74	41,284	219,460	470,454	13.4	159,674	37,696	359,680
Transportation Equipment	180	71	55,426	264,195	361,359	10.3	17,094	20,735	91,893
Machinery, except Electrical	783	219	32,328	145,424	316,205	9.0	18,621	23,300	129,587
Primary Metal Industries	155	87	22,373	99,121	206,151	5.9	27,244	11,682	58,337
Printing and Publishing	1,364	178	22,537	86,582	154,672	4.4	8,440	17,756	92,467
Stone, Clay and Glass Products	411	132	13,729	47,474	133,789	3.8	10,826	10,629	57,646
Fabricated Metal Products	586	185	18,805	75,470	131,543	3.8	8,653	13,167	66,871
Apparel and Related Products	511	265	28,543	61,112	98,689	2.8	1,891	21,734	70,423
Lumber and Wood Products	1,042	189	20,739	48,098	76,368	2.2	5,788		
Pulp, Paper and Products	86	57	8,126	33,764	68,224	1.9	7,298	4,674	32,992
Furniture and Fixtures	476	94	9,819	29,589	51,606	1.5	2,087	5,819	22,984
Electrical Machinery	85	28	4,915	19,672	34,932	1.0	1,407	1,946	12,163
Textile Mill Products	67	36	8,636	22,209	33,754	1.0	2,870	8,438	29,838
Leather and Leather Goods	107	35	3,410	6,766	10,180	.3	337	1,690	5,962
Miscellaneous Manufacture	370	59	10,446	38,638	51,218	1.5	6,702	3,284	14,458

TABLE 17
AIR POLLUTION PROBLEMS FROM THE MANUFACTURING INDUSTRIES

INDUSTRY GROUP	VISIT*	QUESTION-NAIRE‡	TOTAL
FOOD	16	12	28
Abbatoirs and Rendering Plants	7	8	15
Grain Mills	2	4	6
Stockyards	4	0	4
Other	3	0	3
CHEMICALS AND ALLIED PRODUCTS	26	7	33
Fertilizer	8	2	10
Carbon Black	2	5	7
Cottonseed Oil	9	0	9
Other	7	0	7
PRODUCTS OF PETROLEUM AND COAL	10	1	11
Refineries	7	1	8
Other	3	0	3
PRIMARY METALS	2	0	2
RUBBER PRODUCTS	2	0	2
PAPER PRODUCTS	2	0	2
OTHERS	0	9	9

*Cities over 10,000 population were visited.

‡Questionnaires were mailed to health officers in the town and county health units not visited.

some of the chemical industries are located in the interior oil fields at Longview, Pampa, Borger and Odessa.

A vast array of materials in the form of odors, gases, liquid and solid aerosols, dusts and vapors are emitted to the atmosphere by chemical industries. However, no attempt was made to identify all possible pollutants from this source.

Carbon black plants were found to be a major source of air pollution in certain areas. Due to the nature of the process, one might expect even more problems. Under Texas law, carbon black is produced from sour gas and gas that comes from oil wells under such conditions that it would have to be vented or treated unless burned for carbon black production. Carbon black is made by burning gas against a cooling surface, thus causing carbon deposits. There are two general methods of production — the contact and the furnace methods. The contact method seems to produce the most air pollution problems. Most of the carbon black is produced in the Panhandle oil fields, but there also is production in the Odessa area and on the Coast. Texas usually produces about three-fourths of the carbon black of the country, most of which goes into rubber manufacturing.

Fertilizer plants were the basis for ten complaints—eight in the cities visited and two from questionnaires. Dust, odor and fumes or gases were indicated as the chief offenders. Besides being bothersome to the residents, the pollutant in one case was thought to have caused damage to a person's property.

Insecticide plants caused two separate problems from dust and odor: drilling mud production gave rise to two dust problems; one acid plant produced fumes and odors which caused discomfort to citizens and damaged property and vegetation; and two other odor problems were encountered.

3) **Petroleum industries:** The really great industrial development of the State started with the beginning of petroleum refining. Prior to the 1954 census, petroleum refining was the leading industry of Texas in annual value added by manufacture.[17] Now food and chemicals have surpassed it. Petroleum refining and its associated industries have developed the petrochemical industries and have furnished market and raw material for many other industries. In recent years about 70 percent of the crude oil produced in Texas has been refined in the State. Eighty-four refineries in the State, employing 36,317 people, added a value of $349,424,000 in 1947; 77 refineries employing 39,627 people added a manufacturing value of $452,750,000 in 1954. Thus, one can see a trend toward larger and fewer individual plants. The largest plants are located at the Gulf ports with the two largest concentrations being along the Houston Ship Channel and on the Sabine-Neches Channel at Port Arthur, Beaumont and other points.

Eight different problems were found to be associated with the refining industry: seven in the cities visited and one from the more rural areas. Gases and odors were the primary objection, but in two cases property damage was also evident. Products of petroleum, namely asphalt road-topping plants, accounted for an additional three problems. Two of the complaints concerned smoke and odor, while one concerned dust.

4) **Other Manufacturing Industries:** The metals industry, one of the lesser manufacturing industries in Texas, reportedly created two problems in the State. A foundry and a smelter were the source of smoke and odor. The smelter created discomfort to local residents on occasions and infrequently damaged property and vegetation. Two air pollution problems were due to smoke and odor from the production of synthetic rubber. No damage was claimed, but the pollutant was quite annoying to citizens. The pulp and paper products industry is of concern principally because of the emission of materials which cause a strong unpleasant odor over a rather large area near the pulp mills. Two odor problems were indicated from this source, but no damage was claimed.

Nine other miscellaneous problems were indicated by questionnaires throughout the State. These were of minor significance and were scattered over many of the remaining manufacturing industries.

5) **Other industries:** Dust arising from operations in the construction industry, particularly road construction, is frequent cause for public complaint. However, these are usually only for a short time. The trade industries cause emissions

of pollutants including hydrocarbons from petroleum bulk storage plants and retail filling stations, smoke and odor from automobile scrapping and odors from restaurants and markets. Four smoke problems were noted from the burning of automobile bodies. No complaints were registered against the service industries. However, laundries, dry cleaning establishments and others may create odor problems at times and are a source of organic materials.

In order to gain an insight into the air pollution control activity of the manufacturing industries, questionnaires (Appendix A) were mailed to all those with 100 or more employees. A total of 974 were mailed, and 543, or 56 percent, were completed and returned. (Table 18.) Of the 543 industries responding, 191 were using some air pollution control equipment; 44 were planning new or additional controls; 84 had made private air pollution evaluations of their plant emissions; and 67 of these 84 would be willing to release the results of their evaluation to official agencies.

Waste Disposal Operations

Refuse disposal: The method of disposal used for garbage and rubbish is an important factor in controlling air pollution. The burning of refuse on open dumps or locally by private individuals is one of the poorest methods of disposal from the standpoint of air pollution. The open dump is a public health nuisance and is not a sanitary means of refuse disposal. One reason for the criticism of this method of disposal is that complete combustion of the refuse is seldom attained, resulting in production of a wide variety of gaseous and particulate matter including odors, aerosols, oxides of nitrogen and sulfur, aldehydes, organic acids and other organic matter. Also, since open burning of the refuse is usually not complete, putrescrible material remains in an ideal condition for fly and rat breeding.[26]

Properly constructed and operated incinerators are a great improvement over open burning dumps and private "back yard burning," but they may still emit gaseous products of combustion and limited amounts of partciulate matter and odors. The most desirable method of disposal for the elimination of air pollution problems is the sanitary landfill. The sanitary landfill is usually understood to mean a method of disposal whereby all refuse is thoroughly compacted in the ground and covered with two feet of soil or other suitable cover material.

Although other factors could be taken into consideration in defining incinerators, landfills, semi-landfills and open dumps, the following definitions will be used in this discussion:

1) Incinerators—the refuse of a community is burned to ash in a confined area or container.
2) Sanitary landfill—the refuse of a community is not burned and is covered with soil or other cover material at least once each week.
3) Semi-landfill—the refuse of a community is burned before being covered, but is covered at intervals of from one week to three months.
4) Open dump—the refuse of a community is left uncovered for extended periods of time. No covering is used on the refuse and burning may or may not be employed.

The present refuse disposal practices of the cities in Texas with over 10,000 population (1950) are summarized in Table 19. In the State of Texas, the most common method of disposal is the so-called semi-landfill, where the refuse is burned daily but may be covered at intervals ranging from over one week to three months. There are 28 cities in the State using this method. The use of open dumps and landfills are each employed in 18 cities.

The least used method is that of incineration; only three cities use incineration alone, while two others use it in combination with another type of disposal. Various other combinations are used by a few cities.

There are seven cities in the State with over 100,000 population. These cities and their respective method of disposal are shown in Table 20.

From questionnaires received from health officers, it was determined that seven cities below 10,000 population had some complaints from refuse disposal operation. Four complaints concerned smoke, while three others concerned odor.

TABLE 18

AIR POLLUTION ACTIVITY OF THE MANUFACTURING INDUSTRIES*

INDUSTRY‡	Questionnaires Mailed	Replies	Using Controls	Future Controls Planned	Private Evaluations Made	Information Available To Official Agencies
Apparel	96	51	2	0	0	0
Chemicals	88	52	38	11	25	20
Electrical	9	6	3	1	0	0
Fabricated Metals	65	36	3	1	4	3
Food and Kindred	195	106	41	9	13	6
Furniture	35	13	8	0	0	0
Instruments	9	7	1	0	0	0
Leather	17	6	0	0	0	0
Lumber and Wood	62	27	13	1	1	1
Machinery	92	53	15	5	2	2
Miscellaneous	10	2	2	0	2	1
Natural Gas	13	10	3	0	2	2
Ordnance	1	1	1	1	0	0
Paper	22	14	5	1	3	3
Primary Metals	36	15	8	2	6	4
Printing	40	16	1	1	0	0
Products of Petroleum	40	40	21	8	15	13
Rubber Products	7	6	3	0	0	0
Stone, Shell, Glass	78	45	8	2	10	8
Textile Mills	26	19	7	0	1	1
Transportation	33	18	8	1	3	3
TOTAL	974	543	191	44	84	67

‡Size of Industries—over 100 employees

*Industrial Activity from Industrial Questionaire—May 1, 1958

TABLE 19

THE REFUSE DISPOSAL PRACTICES OF THE CITIES IN TEXAS*[3]

NO. OF CITIES	METHOD OF DISPOSAL
18	Open Dump
3	Incinerator
18	Landfill
28	Semi-Landfill‡
1	Dump and Fill
1	Dump and Semi-Landfill‡
1	Dump and Incinerator
1	Landfill and Incinerator

*Cities Over 10,000 Population

‡Burn Combustibles then Cover

TABLE 20

REFUSE DISPOSAL PRACTICES OF THE LARGE CITIES

CITY	METHOD OF DISPOSAL
Austin	Sanitary Landfill
Corpus Christi	Semi-landfill
Dallas	Sanitary landfill
El Paso	Sanitary landfill
Fort Worth	Dump and incinerators
Houston	Incinerator and sanitary landfill
San Antonio	Sanitary landfill

Discomfort to citizens was the only effect noted. Of the 71 cities visited personally, nine were reported to have received complaints due to the smoke of burning dumps. Four of these nine also indicated that the odor was very obnoxious. Again, the only effect of the pollutant noted was that of discomfort to local citizens.

Backyard incineration of refuse is not practiced much in urban areas. Shown in Table 21 are the controls or ordinances exercised by Texas cities to prohibit or restrict local backyard burning.

In many cases, even though the city had no ordinance to control or restrict such local burning, the practice was discouraged. In addition, efficient and periodic pick-up and disposal of the refuse in many cities had convinced the local public that the backyard incinerator is an inferior method of disposal.

Sewage Disposal: As indicated by health officers, 17 smaller towns (below 10,000 population in 1950) were troubled by odors from sewage disposal operations. Of the 71 cities visited, 18 had registered similar complaints. The problems arose chiefly from sewage treatment plants; however, odors from sewer lines and oxidation ponds also caused some complaints. One interjurisdictional situation was encountered where residents reported offensive odors from untreated sewage discharged into the Rio Grande by an adjoining city.

In most cases of complaints from sewage disposal operations, steps are being taken to alleviate the situation. Plant facilities are being expanded, new plants are being constructed or in many cases engineers are being consulted to assist in bringing about a satisfactory solution to these situations.

Radioactive Material

At present there are two experimental reactors in operation with two more planned to be placed in service in the latter part of 1958. One of the reactors is being tested for propulsion of aircraft. The reactor is flown over a designated corridor and air monitoring programs are set up along its route to sample air for radioactivity.

The need to protect the general public from any possible hazard from radioactive substances has been recognized by the State in regulations which require registration of all radiation producing equipment or radioactive material and also require safe disposal of all types of radioactive wastes in such a manner that it, ". . . will not cause contamination of the environment that may result in a person or persons receiving an excessive radiation dose . . ."[27] Other requirements such as air monitoring, handling, storage, et cetera, are cited in these regulations.

Dust Storms

Texas soils are of prime importance to its economic welfare. Years ago the soils in the western half of the state of Texas were fertile and were covered by a growth of vegetation which provided good protection for the soil. During this period the western portion of the State was used primarily for ranching. As the State became populated, this area gave way to cultivation by the farmer who wanted to produce crops. Since then, continuous cropping and soil erosion have combined to reduce this valuable asset.

TABLE 21

CITY CONTROLS OF PRIVATE REFUSE INCINERATION

ORDINANCE*	NUMBER OF CITIES	PERCENT
Private Refuse Incineration Prohibited	28	39
Private Refuse Incineration Restricted	19	27
No Ordinance or Restriction	24	34
TOTAL	71	100

*The information was obtained by visits with the local health officers, but the ordinances were not all reviewed for their content.

The Great Plains region, composed of the High Plains and the Edwards Plateau (see Frontispiece), is the area most adversely affected by soil erosion from wind and subsequently by blowing dust and sand. This area occupies 41.5 million acres. The character of the soil on the High Plains varies from the heavy soils or "hardlands" in the northern part to the light sandy soils in the southern part. The cover on the soil is of great importance in reducing soil erosion by both wind and water. The crops grown on these soils are varied. Wheat is the predominant crop in the heavy soils of the northern part, while cotton, grain, and sorghum are produced on the southern sandy soils. Wheat usually provides more cover for the soil than is provided by row crops. In addition, wheat has a longer growing period than does cotton and sorghum, thus providing cover for a greater portion of the year.

Less than five percent of the land of the Edwards Plateau is under cultivation and most of this is in the transitional area where rainfall is greatest. Most of the land is used for grazing of cattle, sheep, and goats. During the drought period, from 1950 to 1956, the vegetation in this area suffered greatly, leaving vast quantities of land with little or no cover.

Sections of the Trans-Pecos area are also affected by blowing sand and dust. The Trans-Pecos area includes over 11 million acres and occupies the extreme western part of Texas. The soils of the mountains and rough lands in this area have developed from limestone and igneous rocks. They are very thin and rocky. Only about two to three percent of this area is tilled, and all of the cropland is irrigated. Of the 272,000 acres of irrigated farms, 92,000 acres are in the El Paso Valley. The principal crops are cotton, alfalfa, small grain, sorghum, and truck crops.

The precipitation for these areas is given in Table 22. Some of the heaviest rainfall occurs during May and June. However, it is usually spotty and occurs in heavy downpours of short duration. Therefore, runoff would be expected to be great. Winter drizzles and slow precipitation over a longer period of time would have a much better effect on wetting the soil, thus eliminating or reducing soil erosion by wind and consequently reducing the frequency of dust storms.

TABLE 22
PRECIPITATION AND EVAPORATION RATES FOR SELECTED AREAS[28, 29]

AREA	PRECIPITATION (INCHES)		ANNUAL EVAPORATION RATE (INCHES)
	1956	1957	
High Plains	10	20	80
Edwards Plateau	10	25	65
Trans-Pecos	5	10	130
El Paso	5	10	90

Temperature and humidity also have a bearing on the frequency of dust storms; warm dry air tends to dry out the soils. The annual evaporation rate, as determined in water evaporation studies by Texas Agricultural and Mechanical College, is extremely high in all of this West Texas territory. (Table 22.)[28]

The climatological factor which plays the largest role in creating dust storms is wind movement. (Table 23.) The highest wind speeds occur during March and April. Although wind velocity may increase only two or three miles per hour in these months, as compared to the months with the slowest speed, this is a great amount of wind movement in one month. For example, a three mile per hour increment means an increase of 2,160 miles of wind movement per month.

Topographical factors combined with climatological effects create frequent dust storms in West Texas. Dust in many of these storms may remain suspended in the air for several days after the storm has passed. This explains the dust storms which carry eastward over the State and even over several states. The sky is obscured by dust, and in some cases, visibility may drop to one-quarter mile or below. The days per month that dust reduced visibility to one-quarter mile or less during 1956 and 1957 are shown in Table 24 for

TABLE 23
AVERAGE MONTHLY WIND SPEEDS AT SELECTED STATIONS (M.P.H.)[13]

STATION	MONTH											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Amarillo	12.8	14.0	15.3	14.9	13.9	14.0	11.4	10.9	11.6	11.9	11.7	12.8
Del Rio	7.7	9.0	9.5	10.4	10.9	11.3	9.8	8.9	7.9	7.8	7.5	7.0
El Paso	10.1	9.8	12.5	12.9	12.0	10.3	9.3	8.8	8.8	8.5	9.1	10.2
Lubbock	9.8	11.0	12.4	12.0	11.2	11.7	8.4	7.9	8.9	8.7	9.6	10.3
Midland	8.4	9.9	11.4	12.6	11.9	11.0	8.5	7.9	9.3	9.0	8.8	8.6
San Angelo	8.9	10.4	11.5	11.4	11.2	11.1	8.5	8.4	8.4	8.2	9.1	8.7

the U. S. Weather Bureau Stations in West Texas. In addition, in 1956, visibility was reduced once to this level in Fort Worth and in Galveston. Table 25 shows the days per month that dust reduced the visibility to three miles or less during 1956 and 1957. The year 1956 is considered a "dry" year, while 1957 is considered a "wet" year.

Meteorologists at the first-order* U. S. Weather Bureau stations record the cause of all reductions of visibility to seven miles and below. However, it was felt that if reductions to six mile visibility was used to compare the frequency of dust storms, interference from local small whirlwinds would be noted. Visibility of one-quarter mile or less is reported in the summaries of these stations, but this value seemed to indicate only the very severe storms. Therefore, reduction of visibility to three miles or below was used as the measure of dust storm frequency. The occurrence of these storms shows a close correlation with the wind velocities. (Table 23.) The highest winds occur generally in late winter or early summer, and this is the time the majority of the dust storms are created.

The effect of these dust storms is widespread and varied. Dust or sand particles picked up in West Texas may carry for many miles before settling out. The distance involved is, of course, a function of both wind velocity and the particle size of the dust. It is not uncommon for dust storms to carry as far as Arkansas and Louisiana.

The first major effect of wind storms is that of soil erosion. The topsoil of the farmer's cropland is being removed, thus depleting soil fertility and productivity. Besides decreasing this valuable resource, dust storms cause a great amount of discomfort to citizens of the State. For example, the housewife's task of housecleaning is increased tremendously. Also, persons suffering from respiratory ailments may have their condition aggravated by high amounts of dust in the air. The storms may also cause damage to property. The paint and glass on automobiles or houses and other structures may be pitted and marred due to sand particles striking the surface at high velocities. This, in turn, increases the cost of upkeep and repair of these exposed objects. In addition, the visibility may be reduced to extremely low values, thus affecting flight operations of both private airplanes and commercial airlines. At times motor vehicles traveling over the highway systems are slowed to a bare movement or even completely halted.

Effective measures to control wind erosion are based essentially on research. Texas Agricultural and Mechanical College System, cooperating with the U. S. Department of Agriculture, studies and evaluates various methods of control, and distributes the information to the farmers and ranchers through the county agricultural agents.[32]

In addition to the major dust storms from soil erosion, many local problems arise from unpaved streets or inadequate cleaning procedures of paved roads in the urban areas. This usually is merely a nuisance in that vegetation and property are continually being showered with dust particles. Paving or oiling dirt and gravel roads and thorough periodic cleaning of the paved surfaces obviously would alleviate this problem.

TABLE 24

DAYS THAT DUST REDUCED VISIBILITY TO 1/4 MILE OR LESS DURING 1956 AND 1957[29]

City	1956	1957
Abilene	5	0
Amarillo	4	1
Del Rio	0	0
El Paso	2	2
Laredo	2	0
Lubbock	0	1
Midland	3	3
San Angelo	2	1
Wichita Falls	4	0

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*A first-order weather bureau station is one that is manned by a professional meteorologist and is equipped to record complete observations on an hourly basis.

TABLE 25
DAYS THAT DUST REDUCED VISIBILITY TO THREE MILES OR LESS DURING 1956 AND 1957[30]

STATION	SEASON*								ANNUAL	
	Winter		Spring		Summer		Fall			
	'56	'57	'56	'57	'56	'57	'56	'57	'56	'57
El Paso	3	6	9	12	14	11	5	0	31	29
Amarillo	11	5	18	13	7	6	7	0	44	24
Midland	6	9	13	21	8	3	7	1	34	34
Del Rio	3	0	6	2	2	1	1	0	12	3
Dallas	2	1	5	1	0	0	2	0	9	2
San Antonio	3	1	4	2	1	0	1	0	9	3
Houston	1	1	4	2	0	0	0	0	5	3
Brownsville	2	1	5	0	0	0	0	1	7	2
Port Arthur	0	0	0	0	0	0	0	0	0	0

*January, April, July, and October are the mid-months of winter, spring, summer, and fall respectively.

Topography and Climatology As Related to Air Pollution

Relationship Between Air Pollution and Meteorology

In Texas, with its greatly expanding population, growing industrialization and urbanization, more and more air-borne waste material is being dumped into the atmosphere, particularly over the large urban areas. The degree to which pollutants accumulate is largely dependent upon the weather. For instance, the measured concentrations of local air pollutants may vary markedly with changing weather even though the total discharge of pollutants remains relatively constant. In the evaluation of the role metorology plays in the dispersion of air-borne contaminants, large-scale patterns can usually be determined from the climatological evaluation of existing weather records available from most U. S. Weather Bureau stations. Small-scale weather patterns, on the other hand, are not always determinable, as they are often dependent upon diversified influences of local topography.

Weather factors not necessarily unrelated which determine largely the degree to which the atmosphere can disperse waste material are: a) wind speed, direction and turbulence; b) stability or, more generally, the resistance to vertical motion of the lower layers of air; and c) humidity, and condensation forms, particularly fog.

Transportation and dispersion of pollutants is essentially proportional to the wind speed. Generally speaking, the higher the wind speed the greater the dispersion of air-borne waste materials. Wind direction with its variability plays an important role in the directional transport and lateral spreading of these waste materials.

Stability plays an important role in the meteorological relationship to air pollution. Temperature change with height determines the static stability of the atmosphere. Temperature normally decreases with height in the atmosphere. The change of temperature with height is called the lapse rate. The smaller the lapse rate, the greater the energy required to effect vertical exchange. When temperature increases with height (negative lapse rate), an inversion condition exists which tends to restrict vertical mixing. Shallow inversions based at or near the earth's surface may be produced nightly under clear skies and with light winds and may inhibit vertical diffusion as long as they persist. This type of inversion usually breaks up in the late morning. If the vertical extent of the inversion is great enough, solar heating during the day may be insufficient to cause the inversion to break up.

The role of humidity, including condensation in the form of drizzle, snow and rain, is not as direct as that of wind and stability. Condensation forms may have a direct effect by the "rain out" or removal of gaseous and particulate material during periods of precipitation. The presence of fog usually limits the solar heating, which affects the degree of vertical diffusion in the lower layers of air. Air pollution, on the other hand, may have a direct effect on weather in that it provides condensation nuclei for the formation of fog.

Investigations of known occurrences of air pollution episodes have identified all three of these weather elements as contributing to the accumulation of abnormally high concentrations of air pollution. The simultaneous occurrence of light winds, stable conditions and fog for brief periods is not particularly a rare phenomenon, especially in hilly country. Experience has suggested that such conditions must persist for several days before abnormally high concentration of air pollution occur. These persistent periods are usually associated with the prolonged stagnation of high pressure systems.

Topography: General

Geographically, Texas lies at that point on the North American Continent where the Gulf Coastal Plain, extending westward from the Atlantic Seaboard, meets the Great Plains sweeping down from Canada between the Rockies on the west and lower valley of the Mississippi on the east. Texas is flanked on the west by the Rocky Mountain system and on the east by the Mississippi Valley. The land area of Texas is 263,513 square miles, and the inland water area is 3,826 square miles. The longest straight-line distance in a general north-south direction is 801 miles from the southern tip near Brownsville to the northwest corner of the Panhandle. The greatest general east-west distance is 773 miles from the extreme eastward bend of the Sabine River in Newton County to the extreme westward bulge of the Rio Grande in El Paso County. Texas thus covers 13° 05' of longtitude and 10° 40' of latitude. In elevation, Texas varies from sea level to 8,751 feet, the altitude at the top of Gaudalupe Mountain in Culbertson County. There are four generally recognized major physiographic regions in Texas, each of which extends into the State from beyond its borders. Each may be divided into a number of subregions. (Frontispiece.)

Climatology: General

From south to north, the Texas climate varies from warm-temperate rainy in the lower Rio Grande Valley to semi-arid (steppe) on the north Panhandle Plain. From east to west, it varies from a warm-temperate rainy climate on the Louisiana border to an arid climate in most parts of the Trans-Pecos.[33] The variety of weather conditions is contributed by Texas' large size, its range in elevation above sea level and its geographic positions with respect to the Gulf of Mexico, the Great Plains and the Rocky Mountains. All of these factors, together with the prevailing winds over this part of the continent, affect the Texas weather. The normals of Texas weather vary widely with both geographic position and season of the year. Over nearly all of Texas, southerly winds prevail throughout most of the year interrupted occasionally by cold air masses and associated cold fronts from the northwest. (Appendix C.) Wind speeds vary over the State from a yearly average of 9.0 m.p.h. at Del Rio in the Rio Grande Valley, to 13.9 at Lubbock in the Panhandle. In general, wind speeds average about 11 to 12 m.p.h. along the Gulf Coast, 9 to 12 m.p.h. in the central interior, about 11 m.p.h. around El Paso in the west and about 14 m.p.h. in the Panhandle areas. Cold air masses moving out of the Northwest and West cause the sandstorms and dust storms that are most frequent in late winter and early spring and are most intense in West and Northwest Texas.

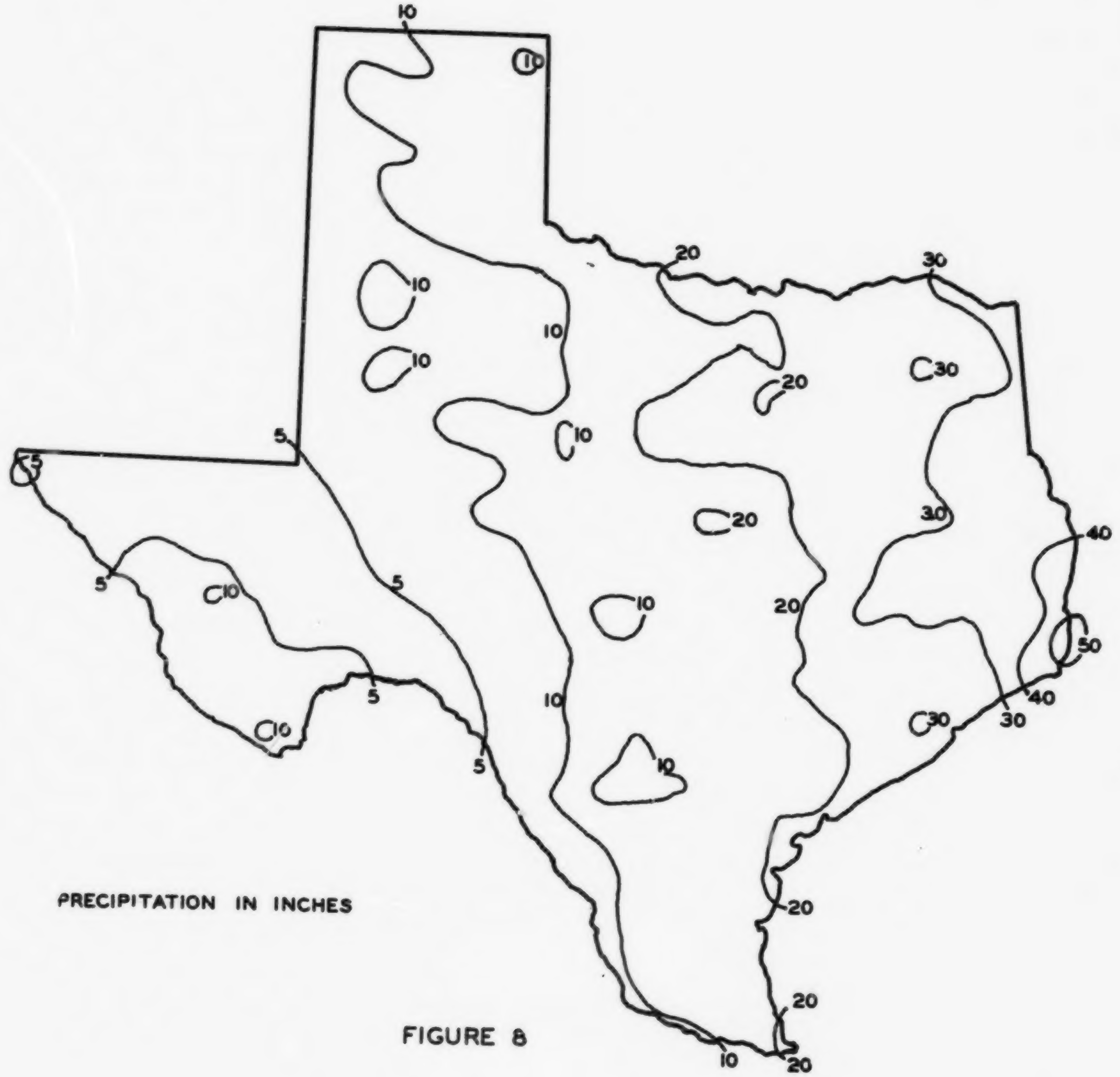
A great amount of the rainfall comes from the clashing of the warm, moisture-laden Gulf winds with the colder winds from the Northwest. These rains are usually of the thunderstorm type and of short duration. Rainfall over the State varies from less than ten inches at El Paso, to more than 55 inches at easternmost Texas. Rainfall for a "dry year," 1956, and a "wet year," 1957, is shown as Figures 8 and 9. These two figures show a marked contrast, not only in total rainfall, but in isohyets or distribution of equal rainfall. Except in the Panhandle area, snowfall, as a rule, is negligible. Annual snowfall in this northwestern section ranges from [illegible] to 25 inches. Cold fronts from the North are known as "northers." Northers, which occur in late autumn, winter and early spring, bring rapid drops in temperature. When there is considerable moisture in the air, the norther is usually followed by clear, frosty weather; the more severe northers reach the Gulf Coast and even the Lower Rio Grande Valley but infrequently bring freezing weather to this area. The average temperatures which vary so greatly over the State are shown as Figure 10. Mean annual temperatures vary from 74° in the Lower Rio Grande Valley to 56° in the northwest Panhandle. Relative humidity ranges from the extremely dry atmosphere at El Paso to the humid conditions of the Gulf Coast.

It has been observed that major air pollution episodes are usually related to the incidence of stagnating anticyclones in or near urban areas for a protracted period (four days or more). During such periods surface wind speeds may become insufficient to carry away the accumulated pollutants of the local atmosphere, thereby causing distressful and possibly hazardous conditions for the inhabitants of that area.

The total number of cases and days of prolonged stagnation (four days or more) for the 21 year period, 1936-1956, is shown as Figure 11.[34] These cases of prolonged stagnation were not present at all in western Texas, but occurred more frequently as the eastern border was approached. The maximum number of cases was seven, occurring near Nacogdoches. In the Dallas, Waco, Austin and Corpus Christi areas, they occurred twice, while in the Houston and Beaumont areas they occurred three times. By far, the most common month of occurrence is October, followed by November.

Not all of these cases would necessarily result

TOTAL PRECIPITATION IN TEXAS - 1956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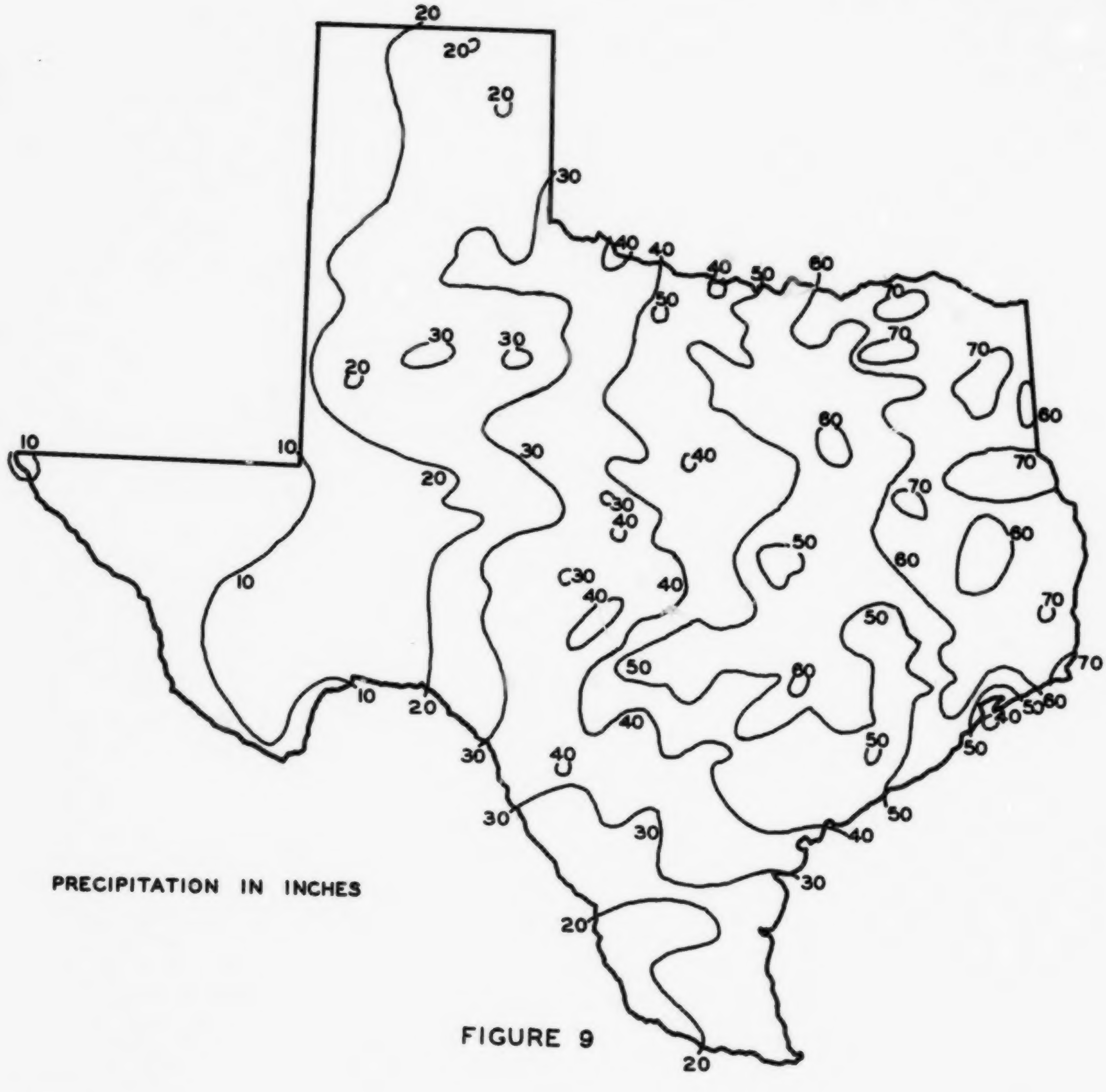
20

PRECIPITATION IN INCHES

FIGURE 8

TOTAL PRECIPITATION IN TEXAS - 1957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40
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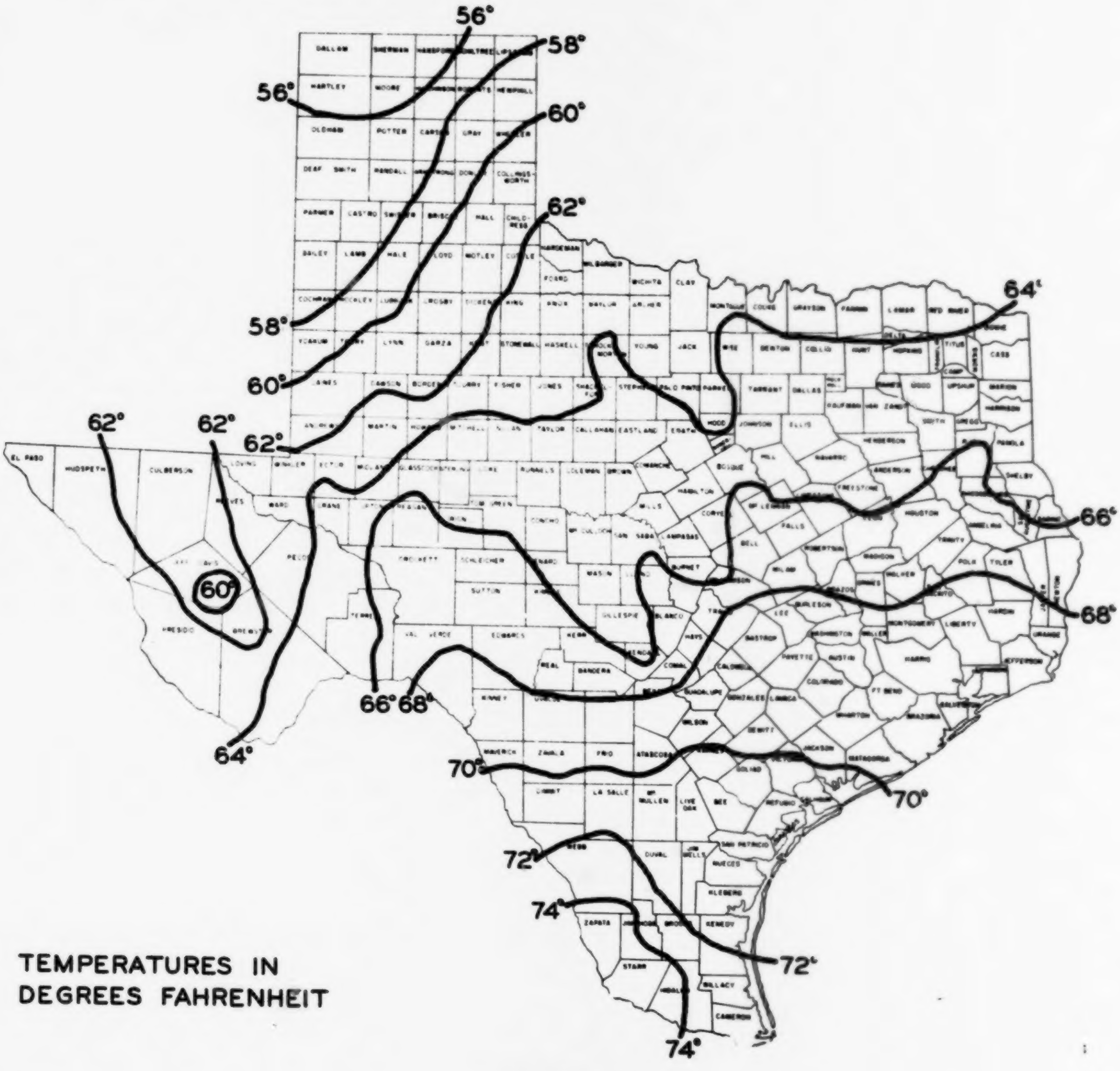
20

PRECIPITATION IN INCHES

FIGURE 9

MEAN ANNUAL TEMPERATURES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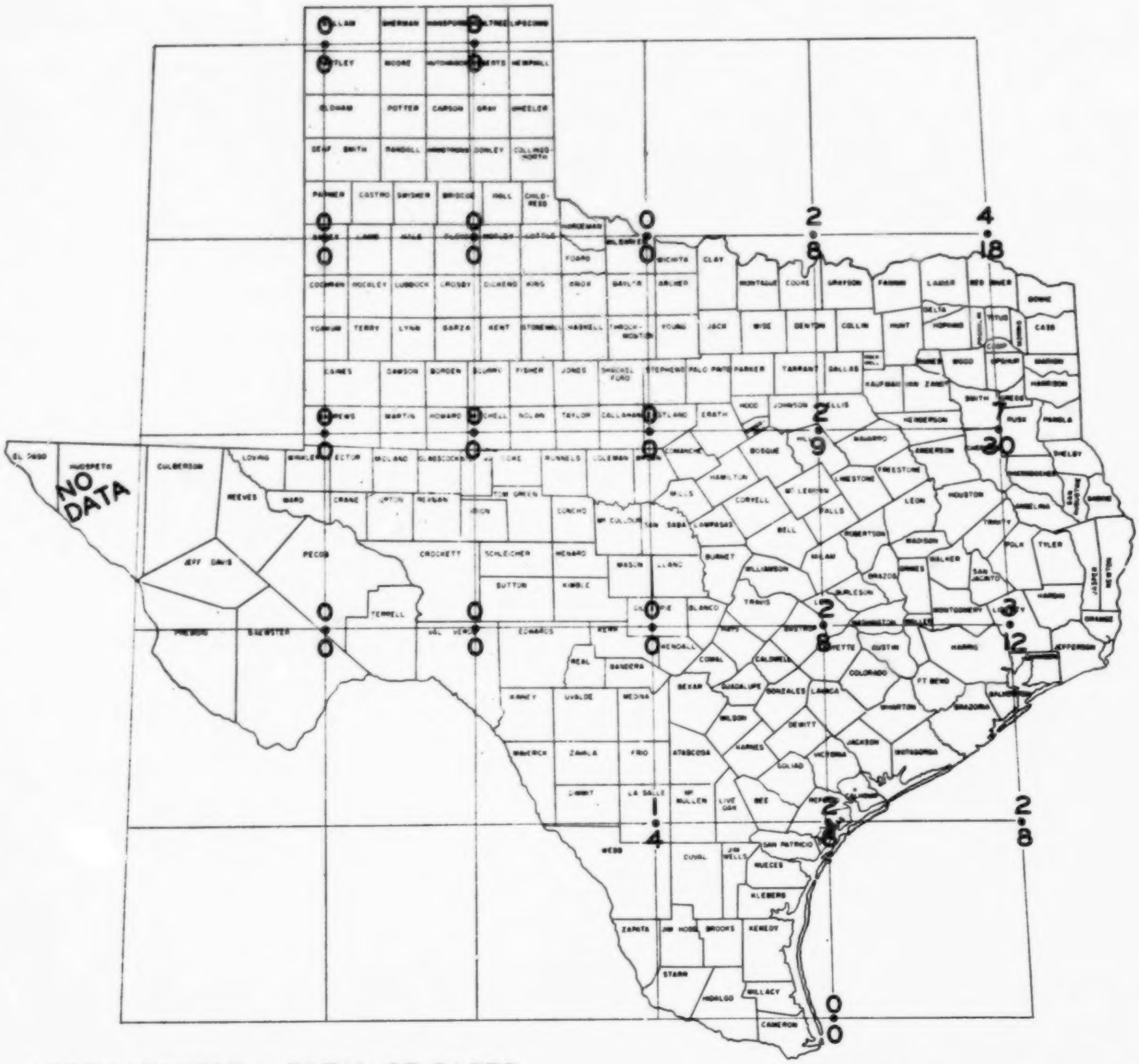
58°
56°
60°
62°
64°
58°
60°
62°
62°
62°
60°
66°
68°
64°
66°
68°
70°
70°
72°
74°
72°
74°

TEMPERATURES IN
DEGREES FAHRENHEIT

FIGURE 10

NUMBER AND DURATION* OF STAGNATION CASES IN TEXAS - 1936-1956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0
0
0
0
0
2
8
4
18
0
0
0
0
0
0
2
9
7
20
0
0
0
0
0
0
2
8
3
12
1
4
2
8
2
8
0
0

UPPER NUMBER - TOTAL OF CASES
LOWER NUMBER - TOTAL DURATION IN DAYS

*DURATIONS OF FOUR OR MORE DAYS WERE USED.

FIGURE II

in air pollution episodes; the presence of calms or light, shifting winds, and appropriate stability is also necessary, as well as sources of air pollution.

Topography and Climatology: Sectional

Gulf Coast Plains: The Gulf Coast Plains are the lowest in elevation of the major divisions and extend from the coast to the Balcones Escarpment, a geologic fault line extending in a great semicircle from the Rio Grande near Del Rio to the Red River just west of Gainesville. This region contains about 40 percent of the area of Texas, and ten of the State's 15 metropolitan areas. Climatic conditions over this 100,000 square mile area vary from warm temperate rainy on the coast and north inland areas to semi-arid in the south inland area. The Gulf Coastal Plains area will be discussed by its three natural subdivisions, which are based partly on surface characteristics and partly on timber types. These subdivisions are:

1) The Coastal Prairies

2) The Rio Grande Plains

3) The Inland Gulf Coastal Plain

Over all these areas, high level inversions are frequent throughout the year. Such inversions may be of significance in air pollution since they limit vertical mixing of the air and may lead to the accumulation of pollutants. The height of these inversions limits the vertical dimension of the atmosphere for mixing, thus limiting the volume of air available for dispersing the air contaminants; however, the heights of the inversions for this area cannot be specified due to insufficiently summarized data. From late spring through fall, these inversions usually break up by noon, but in winter, they may persist all day not breaking up at all but only changing their elevation. Along the coast, this condition is aggravated by the frequent fogs, while on the other hand, the sea-breeze effect, the relatively high wind speeds and the low occurrence of calms help alleviate it. In the more inland areas, less fog, clearer skies and greater sunshine tend to break up these inversions more readily than along the coast, but a greater occurrence of calms tends to aggravate those periods when pollutants would gather under the inversion. Also, because of the higher elevations of the interior, the upper level inversion would be closer to ground level than along the coast. Nocturnal, low level inversions are more frequent in the inland parts of this area than along the coast, but these inversions break up early in the morning.

As a result of these high level inversions and the weather pattern, this area is in a state of rather delicate balance, with conditions intensifying air pollution problems one day and alleviating them another. Generally, the good wind pattern predominates and keeps pollutants from collecting over the urban areas. (Table 26.)

1) The Coastal Prairies comprise a belt about 70 miles wide from tidewater to about 200 feet elevation and extending from the Sabine River to the San Antonio River. It is largely a grassy plain area whose economy is dominated by industry and port commerce. Houston, the largest city and greatest industrial area in the State, is located here as well as the cities of Port Lavaca, Victoria, Freeport, Galveston, Texas City, Baytown, Beaumont, Port Arthur and Orange. Climate over this area is characterized by comparatively uniform temperatures in all seasons with a small diurnal range. Also, the progress of the seasons is retarded with winter lingering into spring and summer into fall with a resulting amalgamation of the seasons. Spring is characterized by brisk winds and frequent showers. Strong southeasterly winds which begin in January give way to the gentler sea breezes (also southeasterly) in June. In late August, the high summer humidity gives way to a more clear, dry air, allowing more radiation at night and the formation of nocturnal inversions. This condition lasts through December. In January and February, cold front activity is at maximum in this area, producing windy, unsettled conditions; only in January when the frequent passage of high pressure areas brings prevailing northerly winds is the prevailing southeasterly wind pattern diminished. The air flow favors the dispersion of pollutants in the Coastal area. The average wind speed is ten to 11 m.p.h., being lowest in the summer and fall (seven to nine m.p.h.) and highest in the winter and spring (11.5 m.p.h.). Calms are infrequent, averaging only three to five percent of the time. Heavy fog is frequent in this area, especially in the winter. These occur from 15 to 47 days per year and are

TABLE 26
WEATHER CHARACTERISTICS FOR THE GULF COASTAL PLAINS AREA [13, 31, 35]

REGION AND CITY	WIND		PERCENT CALMS 0-3 mph	PRECIPITATION (Inches)	RELATIVE HUMIDITY		NUMBER OF DAYS WITH				PERCENT OF POSSIBLE SUNSHINE
	Mean Speed (mph)	Prevailing Direction			6:30 A.M.	12.30 P.M.	Heavy Fog	Clear	Party Cloudy	Cloudy	
RIO GRANDE PLAINS											
Corpus Christi	12.0	SSE	9	28.0	90	62	24	119	119	127	67
Brownsville	11.9	SE	11	29.6	90	60	24	98	141	126	61
Laredo	12.5	SE	6	19.5	82	50	10	131	122	112	....
COASTAL PRAIRIES											
Victoria	9.8	SE	23	35.7	88	56	28	106	126	133	....
Houston	10.2	SE	4	45.4	89	60	15	97	121	147	58
Galveston	10.9	......	3	45.2	84	71	20	143	124	98	63
Port Arthur	10.0	S	5	55.2	81	63	47	108	132	125	....
BLACKLANDS											
San Antonio	8.4	SE	18	27.9	83	55	17	129	130	106	63
Austin	9.6	S	19	35.2	85	55	21	122	161	127	64
Waco	11.7	S	16	33.0	82	54	12	133	105	127	....
Dallas	10.7	SSE	18	34.4	80	54	7	142	98	125	67
Fort Worth	12.6	S	4	33.7	78	50	10	157	98	110	....

significant in that they retard the breaking up of inversions. Fog usually dissipates before noon but occasionally, under stagnant conditions, lingers into the afternoon. In the Houston area, numerous bayous, as well as the Gulf, favor the development of both ground and advective fogs averaging 78 days per year, although only 20 percent of these are heavy fogs.

2) The Rio Grande Plains extend south and west from the San Antonio River to the Rio Grande, covering an area from the Gulf Coast to the Balcones Escarpment. Elevations range from sea level to 1,000 feet in the northwestern part. It is a rolling plain with open prairies in some of the upper portions but usually covered with thick growths of small trees and shrubs. There is little cultivation except in the Rio Grande Valley, southwest of San Antonio, and around Corpus Christi. This area includes the major cities of Corpus Christi, Brownsville and Laredo. San Antonio is on the edge of the area. Along the coast the climate is intermediate between warm temperate rainy and semi-arid. The summer has little day-to-day temperature change, and the sea-breeze effect brings cloudless, windy afternoons. November begins the transition to winter with greater temperature extremes and stronger winds. The mean hourly wind speed is 12 m.p.h., lowest in the fall (9.5 m.p.h.) and highest in spring (14 m.p.h.). The prevailing winds are south-southeast to southeast (from the Gulf) all year. Calms are more frequent than over the Coastal Prairie area to the north, averaging ten percent. Heavy fogs occur 24 days per year. Inland from the Coast the region becomes semi-arid, characterized by an abundance of sunshine, hot summers and mild winters. Progressing in from the Coast, there is less rain, less fog, less cloud cover and lower humidity. The sea-breeze effect vanishes. The prevailing winds are southeast throughout the year with a mean speed of 12.5 m.p.h. at Laredo. Late spring and summer have the highest wind speed, 15.5 m.p.h. at Laredo, while winter shows the lowest speed, ten m.p.h. at Laredo. Heavy fogs are not common, six to ten days per year. Clear, still nights with dry air permit rapid surface radiation of heat and formation of low-level, nocturnal inversions which rapidly break up in the early morning. Thus, conditions for the dispersion of pollutants appear fairly favorable for this inland area. Along the Coast, they would not be quite so favorable as the Coastal Prairie area, but still sufficiently so that pollutants would not tend to gather over the area.

3) The inland Gulf Coastal Plain, composed of the Pine Woods Belt, the Post Oak Belt and the Blackland Prairies, extends from the Louisiana line westward to the Balcones Escarpment and from the Red River southward to the Coastal Prairies and the San Antonio River. The Pine Woods Belt along the Louisiana line has a rolling surface, timbered with pine, and ranges in elevation from 200 to 750 feet. Texarkana and Tyler are located in this area. Just west of this belt is the Post Oak Belt, ranging in elevation from 200 to 500 feet and consisting of rolling to hilly terrain interspersed with prairies. Progressing westward, we enter the Blackland Prairies, a horn-shaped area tapering southward from the Red River to a point near San Antonio, containing the cities of Austin, Waco, Dallas and Fort Worth. This area is a rolling prairie lying immediately between the humid maritime conditions along the Coast and the continental conditions of the great inland prairies. During the winter months, when northerly winds are frequent, the continental influence is predominant. During the summer months, southeast and south winds predominate and the maritime conditions prevail. At San Antonio northerly winds prevail during the winter months while southeasterly winds prevail during the summer. The mean wind speed is 8.4 m.p.h., higher in the spring (9.3 m.p.h.) and lower in the fall (7.5 m.p.h.). Due to oragraphic lift of air carried over the area by southeasterly winds, low stratus clouds frequently develop during the night retarding radiation. They dissipate before noon. At Austin, prevailing winds are from the south with a high frequency of northerly winds during the winter. The mean wind speed is somewhat higher than at San Antonio, 9.6 m.p.h., ranging from 11.0 m.p.h. in spring to 8.0 m.p.h. in fall. In the northern section, southerly winds prevail all year, but from December through February, northerly winds are frequent. The mean wind speed is 11.0 m.p.h. to 12.5 m.p.h., highest in spring and lowest in fall. Calms occurring over the inland area average about 20 percent of the time. Days of heavy fog are more frequent in the southern portions (17-21 days per

year) than in the northern portion (7-10 days per year). As in the Coastal Prairies high level inversions occur frequently in this region. As compared to the Coastal Prairies, the winter "northers" disperse this condition more frequently, and the higher average wind speed disperses the pollutants better. The much greater frequency of calms, however, allows more periods when the pollutants tend to collect. Generally, the balance of conditions is favorable to the dispersion of pollutants.

The North Central Plains: This area extends from the Blacklands westward to the High Plains of the Texas Panhandle and from the Red River southward to the Colorado River. Partly timbered in the eastern part, mesquite woodlands cover most of the remainder, though it originally was largely prairie. The surface is rolling with some hill ranges and varies in elevation from 700 to 2,500 feet, becoming progressively higher toward the west. In the eastern section, the country is rolling to hilly. In the extreme southeastern section, there are wide expanses of prairie country; this is an eroded area transversed by several deep valleys with much broken and mountainous country. The western half of this section, known as the Rolling Prairies, is an undulating terrain of 1,000 to 2,500 feet elevation, transversed by occasional low, flat-topped mountains and partly covered by mesquite woodlands.

The North Central Plains area has a warm temperate rainy climate in the southern and eastern portions and a semi-arid climate in the western and northern portions. It is characterized by rapid changes in temperature, marked extremes both daily and annual and by erratic rainfall. Rapid cooling at night results in frequent nocturnal inversions which are quickly broken by daytime heating. The prevailing wind direction is southerly with an average speed of 11.4 m.p.h. at Wichita Falls and 13.3 m.p.h. at Abilene. Rather strong winds are observed in all months, while strong, gusty winds occur frequently. Weather data are available from two cities in this area, Abilene and Wichita Falls. (Table 27.)

At Abilene, southerly winds prevail over the year with a frequent north wind in the winter. At Wichita Falls, southerly winds prevail over the year except for January and February when north winds prevail. Conditions for the dispersion of air pollutants in this area appear to be good. The high-level inversions characteristic of the Gulf Coastal Plains are not present in this area. The high wind speed (which is consistently high over the entire year) would tend to disperse pollutants. Heavy fog is infrequent in this area.

The Great Plains: The Great (Western) Plains that lie east of the base of the Rockies extend down into Texas on the high ridge of the Panhandle and extend south and southeast to the Balcones Escarpment west of Austin. There are two sub-divisions: (1) the High Plains of the Panhandle and (2) the Edwards Plateau of southwestern Texas.

1) The High Plains area is a flat plain sometimes as level as the sea but with draws and canyons where several rivers cut through. Elevations run from 2,500 to 4,300 feet. The High Plains have a climate typical of a semi-arid region. Droughts occur with monotonous frequency. South and southwest winds prevail over the entire year. Average wind speeds vary from nine m.p.h. in the southern portion to 14 m.p.h. in the north and central. Winds are greatest in the spring and fairly constant over the rest of the year. Wind speeds are characteristically high because the feature-less, timberless area offers little resistance to wind movement and because of the area's nearness to the paths of movements of high and low pressure areas (north of the Panhandle) which tends to cause strong winds. Calms are quite infrequent (averaging six percent). The Panhandle region is subject to rapid and large temperature changes, characteristic of its semi-arid climate, especially during the winter months. Fog and drizzle due to the upslope from the east occur quite frequently during winter and spring months but generally clear by noon. The formation of nocturnal inversions (the low-level radiation type) is frequent, but they are quickly broken up the next day. The wind patterns, which disperse pollutants readily, are also instrumental in the great dust storms that plague this area.

2) The Edwards Plateau has an elevation of 700 to 2,500 feet. The interior portion of the Plateau is usually rolling but has some level topography. In the region near the Balcones Escarpment, stream erosion has formed a broken,

mountainous country with some deep canyons. This area also has a prevailing semi-arid climate. Nocturnal inversions are frequent but quickly dispersed. Days of heavy fog are few, and the average wind speed is high (10.5 m.p.h. at San Angelo). Conditions for the dispersion of pollutants appear good over the Edwards Plateau also, except perhaps in the more mountaineous hill country to the east. Weather data for the Great Plains are available from five cities in this area. (Table 28.)

Trans-Pecos Mountain Area: The Trans-Pecos area is a plateau 3,000 to 5,000 feet high, lying west of the Pecos Valley. It is transversed by several mountain ranges (part of the Rocky Mountain System) having a general northwest to southeast trend. There are five subregions in this area: (1) the Stockton Plateau, which is an extension of the Edwards Plateau, an area of rolling-to-broken plain of elevation 2,000 to 4,000 feet; (2) the Big Bend area, which is located within the southward swing of the Rio Grande River. The elevation of the plateau is from 2,000 feet at the Rio Grande River to 5,000 feet in its northern part, with mountains rising to more than 7,000 feet; (3) the Davis Mountain area, which is a small region located northwest of Big Bend. The elevation of the plateau is 4,000 to 5,000 feet with an outstanding mountain area rising to over 8,000 feet; (4) Diablo Plateau is a high plateau rising 3,500 to 5,000 feet with the Guadalupe Mountains rising to heights of 8,700 feet, highest in Texas. It is located between the Davis Mountains and El Paso; (5) Upper Rio Grande, the area around El Paso, with a plateau elevation of 3,500 to 4,000 feet and mountains rising to over 7,000 feet. All of this Trans-Pecos area is extremely sparsely settled and sparsely vegetated except for the El Paso area. The climate varies from semi-arid on the eastern edge of this area to arid in the west.

El Paso's arid climate is characterized by abundant sunshine, high summer temperatures, very low humidity, scanty rainfall and a relatively cool winter season. The mean wind speed is 10.7 m.p.h., highest in spring (12.8 m.p.h.) and lowest in fall (9.4 m.p.h.). Calms occur 15 percent of the time, being more frequent from August to February. The prevailing wind direction is south from July through October, north from November through June. Precipitation averages a scant 7.8

TABLE 27

WEATHER CHARACTERISTICS FOR THE NORTH CENTRAL PLAINS AREA[13]

CITY	WIND		PERCENT CALMS	PRECIPITATION	RELATIVE HUMIDITY		NUMBER OF DAYS WITH				PERCENT OF POSSIBLE SUNSHINE
	Mean Speed (mph)	Prevailing Direction	0-3 mph	(Inches)	6:30 A.M.	12:30 P.M.	Heavy Fog	Clear	Partly Cloudy	Cloudy	
Abilene	13.3	S	6	22.6	75	47	5	151	99	115	71
Wichita Falls	11.4	S	5	26.6	75	49	12	163	97	105	...

TABLE 28

WEATHER CHARACTERISTICS FOR THE GREAT PLAINS AREA[12, 31, 35]

REGION AND CITY	WIND		PERCENT CALMS	PRECIPITATION	RELATIVE HUMIDITY		NUMBER OF DAYS WITH				PERCENT OF POSSIBLE SUNSHINE
	Mean Speed (mph)	Prevailing Direction	0-3 mph	(Inches)	6:30 A.M.	12:30 P.M.	Heavy Fog	Clear	Partly Cloudy	Cloudy	
EDWARDS PLATEAU											
Del Rio	9.0	SE	16	18.6	79	53	6	153	118	94	63
San Angelo	10.5	S	14	19.8	70	42	4	167	98	100	...
Midland	9.1	SSE	12	16.2	67	40	13	174	94	97	...
HIGH PLAINS											
Lubbock	13.8	SW	7	18.9	74	44	11	172	102	91	...
Amarillo	13.8	SW	6	21.1	73	45	23	161	109	95	72

inches per year, and the relative humidity runs 53 percent at 5:00 a.m. to 28 percent at 5:00 p.m. Percent of possible sunshine averages 82 for the year, and days of heavy fog average one per year. Nocturnal inversions are frequent but are quickly wiped out the next morning. Conditions for the dispersion of pollutants appear generally good, but in this mountainous region, there are periods of calm when pollutants may linger over the area.

Current Research and Investigations

A number of investigations have been made regarding air pollution in the State of Texas. These vary from detailed sampling and analysis to evaluation of situations by observation.

National

During 1957, six Texas cities were cooperating in the National Air Sampling Network of the United States Public Health Service. The sampling sites in five of these were located in urban areas; these cities were Corpus Christi, Houston, San Antonio, Dallas and El Paso. The sixth station was selected in a rural area near Port O'Connor. Upon completion of the 1957 sampling program, three cities, El Paso, San Antonio, and Corpus Christi were discontinued, and Waco, Austin, and Fort Worth were added. Volunteers, usually of the local health department, collects the samples at two-week intervals and send them to the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio for analysis. The samples are analyzed for total particulate matter and organic matter. (Table 29.)

The average results of samples collected by the Network in Texas for 1957 are reported with the permission of the city health officers of Corpus Christi, Houston, San Antonio, Dallas and El Paso, and the county health officer for Port O'Connor. The samples collected by the Network are for 24 hour duration. No direct comparison among these cities is intended.

The Texas State Health Department at Austin and the City Health Department at El Paso have also been participating in the U. S. Atomic Energy

TABLE 29

AVERAGE HI-VOLUME PARTICULATE LOADINGS NATIONAL AIR SAMPLING NETWORK FOR TEXAS 1957[36]

STATION	No. of SAMPLES	PARTICULATE MATTER (a)	ORGANIC MATTER (a)
Port O'Connor†	9	61	1.3
Corpus Christi*	26	69	3.0
Houston*	26	136	8.3
San Antonio*	25	138	4.4
Dallas*	24	121	7.1
El Paso*	27	218	6.6

(a) Values in micrograms per cubic meter of air (ug/CuM).

†—Samples collected continuously for 30 days.

*—24 hour samples once every two weeks.

Commission's air sampling and fallout program. Gummed paper is placed in a horizontal position to collect the fallout. Samples are taken on a continuous basis, being replaced twice weekly. When Continental or Pacific United States weapons tests are scheduled, samples are taken every 24 hours. These are sent to the Atomic Energy Commission for analysis. High-volume samples are collected on the same basis as the gummed paper samples but this program is administered by the Radiological Health Program of the U. S. Public Health Service. More recently rainwater samples have been collected to determine the radioactive wash-out. The collected samples are also mailed to the Radiological Health Program of the U. S. Public Health Service. More recently rainwater samples have been collected to determine the radioactive wash-out. The collected samples are also mailed to the Radiological Health Program of the U. S. Public Health Service for analysis.[37]

The U. S. Department of Agriculture is conducting research on the quality and economics of cotton gin operations at three separate installations—Messia Park, New Mexico; Stoneville, Mississippi; and Clemson, South Carolina. Some work is being done on the matter of assessment of air pollution potential and control measures and is a cooperative effort by the U. S. Public Health Service and the U. S. Department of Agriculture. Most of this work is being done at Stoneville, Mississippi. The findings of these studies have not yet been released, but the information should be of material assistance to gin owners in planning an adequate and efficient air pollution control program. Although none of these studies are being conducted in Texas, it is certain that their results and recommendations would be applicable to the gins in Texas.

State

The primary responsibility of the State in this field has been to aid local health departments through limited technical assistance by field visits for sampilng work and direct observation of problems and by collecting and disseminating information. The Division of Occupational Health has held responsibility in the field of air pollution for nearly two years.

The Texas State Department of Health through the Division of Occupational Health, formerly the Industrial Hygiene Section of the Division of Sanitary Engineering, has made some investigations concerning air pollution problems. These studies have generally pertained to the refineries and chemical plants in the coastal cities. However, other investigations have been made of cotton gins and carbon black plants throughout the State. The State Department of Health also participated in the public hearings on air pollution held at Houston and La Marque in 1952.

Local

Two local agencies are carrying on limited sampling programs. These are El Paso-Hudspeth County Health Department and Harris County Health Department.

The El Paso Health Department is doing more sampling work than any other organization in the State. Besides cooperating in the National Air Sampling Network and the Atomic Energy Commission Sampling Program, they are conducting further air analysis. The city council approved an appropriation of $15,500 on January 1, 1957 to the City-County Health Department to make a detailed study of the air pollution problem of their city. A sampling program was then initiated to determine the type, extent, and effects of the air pollutants. A demonstration project grant from the Public Health Service was received to assist in support of this study.

The sampling began with the collection of dust at 32 dustfall stations located at representative places in the city of El Paso and the adjoining city of Juarez, Mexico. The samples were collected at the end of 30 days and analyzed for the following: total solids, ash, chlorides as Cl, acidity to phenolphthalein as CO_2, fluorides as F, and phosphates as PO_4. Due to the large amount of laboratory work involved, the number of sampling points and location of dustfall stations were modified in February 1958. The procedure now followed is similar to "Recommended Standard Methods for Continuous Dustfall Samples," Air Pollution Control Association Journal, Volume 5, Number 3, November 1955. There are now 16 sampling sites, and each is collected at three-month intervals.

In order to determine the presence of hydrogen sulfide and some unspecified mercaptans in the atmosphere, an American Iron and Steel Institute (A.I.S.I.) strip filter paper sampler, using filter papers impregnated with lead acetate, is used. Aldehydes, nitrogen dioxide, and total oxidants are collected in gas absorbing solutions and analyses are made in the laboratory. The samples are collected at three stations twice each week. A tentative schedule of operations also called for sulfur dioxide samples to be collected two or three times weekly using a portable windspeed and direction finder to pinpoint the source.

The Harris County Health Department has done some sampling over the past few years. Table 30 summarizes the sampling activity for the period of 1954 through July 1957.

TABLE 30

NUMBER OF SAMPLES COLLECTED BY HARRIS COUNTY HEALTH DEPARTMENT[38, 39]

Type of Samples	NUMBER OF SAMPLES PER YEAR			
	1954	1955	1956	1957 (1st Half)
Dust	15	....	30	27
Fallout	36	56	18	....
Hydrogen Sulfide	....	11	....	....
Sulfur Dioxide	....	38	....	....

Since this division handles both stream and air pollution control, much of the effort is devoted to water pollution control. Also, a great amount of the sampling activity has been devoted to water pollution control.

A few other cities have done some sampling work (mainly dustfall), but insufficient budgets, personnel, and facilities have limited their activities to a minimum.

TABLE 31

HOUSTON DUST AND PARTICULATE MATTER*[42]

AREA	NUMBER OF SAMPLES TAKEN	PARTICULATE MATTER (a)		AVERAGE ORGANIC MATTER (a) (b)	ORGANIC AS PERCENT OF PARTICULATE
		AVERAGE	MAXIMUM		
Downtown	7	106	187	8.2	7.7
Harrisburg	8	148	273	10.1	7.4
Galena Park	14	137	221	10.0	7.8
Greens Bayou	7	206	335	8.3	5.7
Jacinto City	7	135	228	8.1	7.0
Pasadena	8	105	146	7.1	7.0
Baytown	8	91	169	5.5	6.9

*Samples collected during period of May 1956-May 1957.

(a) Values in micrograms per cubic meter of air.

(b) Benzene soluble portion of particulate matter.

Private

In May 1956, the Houston Chamber of Commerce retained the Southwest Research Institute of San Antonio to conduct an impartial study of the air pollution situation in Houston. The cost of such a study was reported to be $125,000 for the first year and $35,000 for a second year if the study was continued.[40]

To indicate the status of the air pollution situation, the Southwest Research Institute used a three-stage program.[41]

1) Sampling and analysis of the atmosphere
2) A meteorological study
3) A study of the possible damage to vegetation

The results of the first year's operation were interpreted by the Institute to indicate that:[45]

1) The air pollution problems are of a localized nature in areas downwind from specific sources rather than community-wide.
2) Sulfur dioxide concentrations were in the same range as values for coal-burning cities with control activities.
3) Hydrogen sulfide was low most of the time, but a few concentrations sufficient to cause blackening of lead pigment paint were found.
4) There was no evidence to indicate the occurrence of complete air mass stagnation for extended periods of time.
5) Visible damage to two species of trees was attributed to air pollution in a limited area adjacent to the ship channel.

The second year of study is now underway, and it is hoped that the results of the survey will be of assistance to industrial planning for the future growth of the Houston area. Some average results of this study are given in Table 31. The downtown site is away from the heavy industrial areas. The other stations are in the highly industrialized area along the ship channel except Baytown which is on the extreme eastern end of this area. There is a considerable amount of other sampling data contained in their report. Interested parties are referred to it.[42]

Southwest Research Institute is doing research on the automobile exhaust problem. In one study being sponsored by the Public Health Service, they are investigating particulate emissions in auto exhaust gases. Southwest Research Institute has also done research on other aspects of the auto exhaust problem for the Air Pollution Foundation, as well as having done research in other aspects of air pollution.

The Texas Cotton Ginners' Association is currently evaluating the effectiveness of various control equipment used by the gin operators in their associations.[43] By pooling the experiences of many operators, the Texas Cotton Ginners' Association will be able to keep their members advised of the newest developments regarding various control practices. This Association has also worked closely with other organizations in alleviating the major problems associated with cotton gins.

Air Pollution Ordinances and Control Programs

There are no State laws or regulations pertaining specifically to air pollution. State statutes pertaining to "common law nuisances," are used in some areas of the State to abate air pollution nuisances (see Harris County, below).

Dallas

Only one municipality in the State, Dallas, has an ordinance regulating air pollution. This ordinance, passed on April 7, 1953, and effective immediately, delegates administrative and enforcement authority to the building inspector.[44] It provides for regulation of installation and maintenance of solid-fuel burning devices to the end that they do not emit solids in excess of 0.3 grains per cubic foot of gas at 500° F, and any fuel burning device to the end that it does not emit excessive smoke and soot. It prohibits the emission of effluents that endanger health, comfort or safety of the public or cause injury to property and also smoke of a density equal to or greater than number two Ringlemann with certain exceptions. It requires that permits for fuel burning plants be secured; provides that the inspector be unhampered in his work; and provides fines for violations.

In view of the increasingly rapid growth of the city, and responsibilities and duties already places with the building inspector, the present air pollution program should be broadened or made a separate entity to provide the necessary activity for meeting future air pollution problems.

Harris County

At the end of World War II, it was felt that air pollution abatement was needed in the Houston area. As more and more citizens became interested, committees were organized. The committees handled the work of collecting the signatures of complainants in a local area and transmitting the petitions to the State Health Officer with requests that the State use its power to bring about corrections. These committees also conferred with the management of various plants. The State Department of Health made investigations to determine the sources of the air pollutants. The state and county health departments initiated a program of open hearings, and meetings with industrial committees of the Houston Chamber of Commerce, and representatives of industry. A limited alleviation of industrial air pollution was accomplished under this program.

On December 1, 1953, air pollution work was added to the existing county stream pollution control group, and a combined section was formed.[38] This Stream and Air Pollution Control Section of the Harris County Health Department now handles air pollution control by:

1) Investigating air pollution complaints
2) Issuing abatement notices when necessary to accomplish correction
3) Checking on the progress accomplished by the various plants in abating air pollution
4) Filing complaints under the Civil or Criminal Statutes of the State when abatement cannot be accomplished by cooperation.

The legal basis for these latter actions is drawn from State statutes pertaining to "common law nuisances." It is well established that every person is entitled to reasonable enjoyment of life and property, but he must use his own property so that he causes no injury to others, i.e., so that he does not interfere unnecessarily or unreasonably in the exercise of rights common to all citizens. In addition, there are several laws in both the Penal Code and the Civic Statutes, as well as the "Texas General Sanitation Law of 1945," which regulate and prescribe the method of abating nuisances. To cite a specific case applying to air pollution, City of San Antonio v. Hamilton, Civ. App., 180, S. W. 160, a court decreed: "When a business, lawful in itself, becomes obnoxious to neighborhood dwellings, rendering their enjoyment uncomfortable by smoke, noise, offensive odors or otherwise, it is a nuisance which equity will restrain." Coupled with these statutes and various court decisions is a decision handed down by the Supreme Court of Texas in 1951, holding that:

> "where the tortious acts of two or more wrong-doers join to produce an indivisible injury, that is an injury which from its nature cannot be apportioned with reasonable certainty to the individual wrong-doers, all of the wrong-doers may be held jointly and severally liable for the entire damages and the injured party may proceed to judgment against any one separately or against all in one suit."

In the four-year period of 1954 through 1957, 99 nuisance cases were filed in court by Harris County.[38,44] Disposition of these cases showed:

Totaled filed	99
Found Guilty	9
Found Not Guilty	6
Dismissed	78
Pending or Unaccounted	6

The guilty verdicts resulted in fines of from $100 to $200. In many of the dismissed cases there was a substantial compliance before dismissal. This means of air pollution control seems inadequate for Houston's problem.

Committee on Air Pollution

Four areas in the State have local committees on air pollution. These areas are Jefferson County, Corpus Christi, El Paso and Texas City. These committees are advisory bodies only and have no legal mandates to abate air pollution. They serve only to give the public a place to voice complaints on air pollution and possibly to make recommendations to proper authorities. As such they reflect public awareness to and complaints against air pollution. Several of these committees are industrial committees and as such do not represent the public. The industrial committees serve to protect industry and not to serve the interests of the general public.

Jefferson County: In July of 1953, a local air pollution committee was formed to handle the problems in the north section of the County. In January of 1958, the air pollution group took on county-wide status. This committee is formed of local citizens, industry representatives, health department personnel, and the county judge; the committee reviews complaints and attempts to get offenders to handle their own air pollution problems.

Corpus Christi: In November 1954, a pollution prevention committee was appointed by the Mayor of Corpus Christi to investigate air pollution in the city and act in an advisory capacity.

El Paso: In 1952, El Paso's Mayor, recognizing a growing air pollution problem, appointed a committee of five qualified citizens to study the problem. Assistance and advice were asked of and received from the State Department of Health. Working through the Industrial Committee of the Chamber of Commerce, the Mayor's Committee sought as much voluntary improvement as was felt possible. The large industries spent considerable sums of money on control equipment. In 1954, at the time when El Paso was considering the advisability of an ordinance, industry proposed a voluntary program to be guided by an "Industrial Betterment Committee," made up of representatives of all industry in the area. This group was established and has the following fivefold objectives:

1) Seek ways and means of industrial betterment toward abatement of air pollution
2) Cooperation with city, county, and state administrations on industrial betterment
3) Gather information on air pollution abate-

ment and advise the city administration on air pollution control

4) Serve as an advisor on air pollution abatement to present or new industries in the area

5) Publicize beneficial information on industrial betterment

This committee still exists; however, some acute air pollution conditions occasionally occur resulting in numerous complaints. The State Health and General Nuisance Laws are relied on when a nuisance can be proven. On January 1, 1957, the City Council of El Paso approved an appropriation to the City-County Health Department to be expended over a two-year period to "make a detailed study of the air pollution problem in the City of El Paso in order to gather basic scientific data, to assess the type, extent and effects of air pollution in El Paso, to demonstrate methods of control and to plan, organize, and recommend an operating program for proper control thereof." This study is currently under way.

Texas City: In 1952, an air pollution committee representing local industry was formed. All air pollution complaints, regarding industrial emissions, now received by the Galveston County Health Department are referred to this committee for action.

Summary

From this discussion, it may be seen that local activity throughout the State is limited both in geographic extent and in adequacy. There is a need for State encouragement of local programs and for a State program in several areas that for one reason or another cannot handle their own programs.

Zoning

There are various provisions in local nuisance regulations, building codes, zoning laws and elsewhere which deal with air pollution control more indirectly.

One type of measure, which may lead to the reduction of problems associated with air pollution, is proper zoning and subdivision ordinances. A zoning ordinance is a regulatory measure adopted by the community which divides all the land within the community into areas where designated uses may be made of the land, and a subdivision ordinance controls the development of unused land in conformity with the zoning ordinance and the land use plan of the community.

The problem of air pollution may be reduced by designating the areas within which plants having potential problems can locate and stating the controls that must be exercised in controlling emissions. Zoning not only can designate such areas, but also can prevent nonconfirming uses in the area. It is possible to zone out those industries which will not or cannot handle their pollution problems.

In recent years, the urban renewal program has afforded our communities a method of attacking some of these problems in their older areas. Such areas, in most cases, have degenerated into a slum because of mixed land uses. As the area is redeveloped under the urban renewal program, it is made to conform to the over-all city plan where land uses are effectively controlled by a properly administered zoning ordinance.

The cost of city planning comes high, and small cities cannot generally afford it. The Federal Government, therefore, in the urban planning assistance program gives such communities—communities of 25,000 or less according to the latest decennial census—the opportunity to secure such planning by contributing up to one-half of the cost of the planning. This planning program in Texas is administered by the Texas State Department of Health.

Air Pollution Control Legislation of Other States

The growing concern with air pollution is reflected in the growing number of states which have enacted legislation in this field. State laws of various types have been enacted by 20 states and for the Territory of Hawaii.[45] These laws range from simple enabling acts to the forming of state government bodies to regulate pollution, including the issuance of regulations limiting emissions to the atmosphere, and the provision of a comprehensive program of research, study, assistance and control. Prior to 1950, there were five states with air pollution legislation; in the period 1950 to 1956, seven states enacted legislation in this field; in 1957, nine states enacted legislation; and in late 1957 and early 1958 (to March), 21 bills relating to air pollution were submitted in the legislatures of eight states.

A summary of existing state laws relating to air pollution is given in Appendix D.

Resources Available for Research and Investigation

The Division of Occupational Health, Texas State Department of Health, presently cooperates with local health departments and other governmental agencies in the investigation of air pollution problems. It has the services of the Division of Laboratories at its disposal for analytical work to be done on samples collected in the field.

The State has 51 State-supported colleges and 83 private institutions some of which are capable of carrying on studies or research on air pollution.[10] Research work is currently being done at Baylor University College of Medicine, Houston, in cooperation with the U. S. Public Health Service, on "Biochemical Effects of Air Pollutants." Texas Western College, (The University of Texas, at El Paso), through its Chemistry Department is carrying out the analytical work of the present air pollution study of the El Paso-Hudspeth County Health Department. Texas Agricultural and Mechanical College, through its Agricultural Extension Service, is doing work on cotton gin waste control and is working closely with the Texas State Department of Health, U. S. Department of Agriculture, and the Texas Cotton Ginners' Association on this matter. This cooperation is expected to continue in the future. Southern Methodist University has expanded its curricula to include air pollution, and a few students are presently enrolled in graduate work on air pollution.[46]

There are two private research organizations in which facilities are available for research on air pollution — Southwest Research Institute, San Antonio; and Texas A&M Research Foundation, College Station. The former is now making an air pollution survey of Houston-Harris County under contract with the Houston Chamber of Commerce. They are also conducting other research, including some through grants from the Public Health Service. Some private consultant firms are also available for air pollution appraisal work.

Meteorological and climatological data useful in studying air pollution dispersion are available from the U. S. Weather Bureau Stations throughout the State and the State Climatologist at Austin, Texas. (Figure 13, Appendix C.)

Discussion of Air Pollution on a Regional and Local Area Basis

Definition of Regions

For the purpose of examining in detail the air pollution problems and potential problems of the various areas, the State is divided into six regions corresponding generally to the topographic provinces discussed previously. (Figure 12.)

Air Pollution in Region I-A

The Coastal Prairie Region embraces that area from the San Antonio River on the southwest to the Sabine River (eastern boundary of the State) on the east and extends from the Gulf of Mexico inland for about 75 to 100 miles. The region embraces 17 counties.

The Coastal Prairie, for the most part, is level with a rising elevation from sea level on the coast to 300 feet inland. Annual precipitation varies from 35.66" on the west to 55.21" on the east. The area is subject to fogs of varying intensities with frequent ground fogs around the streams and bayous. The prevailing winds are from the south to southeast, and onshore breezes prevail. The region appears to lend itself to good natural ventilation. The regional climatology is discussed further under "Topography and Climatology, Gulf Coast Plains."

The counties of most of the region have had a phenomenal growth since 1940. Populations for the more populous counties are shown in Table 32, along with the region total. The region embraces about 21.5 percent of the 1957 estimated State population.

The region's economy in the past 20 years has changed from an agricultural to an agricultural-industrial economy. Rice and cotton are the principal agricultural crops. The chief industries are lumbering, paper and pulpwood, sulfur mining, petroleum production and refining, petrochemical production, oil field equipment, machinery and supplies, primary metals (iron, steel and aluminum, pipe manufacturing, ship building, metal fabrication, cement and lime manufacturing, rubber and a multitude of small manufacturers of all types.

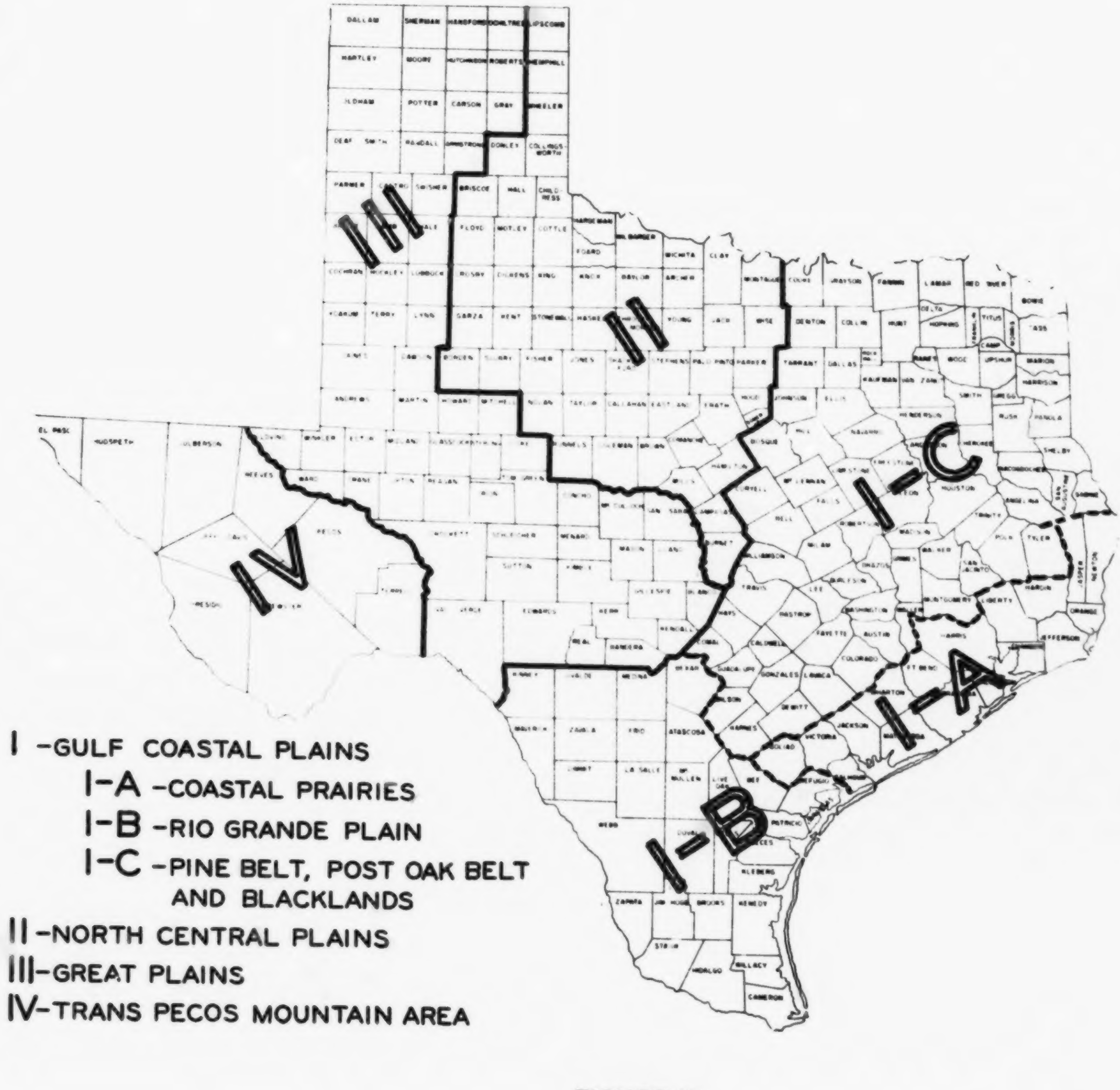
The total employment in 1954 in these counties was 452,494, with the largest employment in Harris County (303,145), Jefferson County (60,500), and Galveston County (29,638). Total

TABLE 32

POPULATION OF SELECTED COUNTIES[10]

County	1940	1950	1957 Estimated
Brazoria	27,069	46,549	68,000
Galveston	78,173	113,066	154,651
Harris	523,961	808,701	1,136,000
Jefferson	145,329	195,083	260,928
Orange	17,382	40,567	55,432
Victoria	23,741	31,241	49,587
Total for Region I-A	1,018,389	1,435,272	1,947,918

DIVISION OF THE STATE FOR REGIONAL DISCUSSION



I -GULF COASTAL PLAINS
  I-A -COASTAL PRAIRIES
  I-B -RIO GRANDE PLAIN
  I-C -PINE BELT, POST OAK BELT AND BLACKLANDS
II -NORTH CENTRAL PLAINS
III-GREAT PLAINS
IV-TRANS PECOS MOUNTAIN AREA

FIGURE 12

income from wages was $1,948,527,436, while the total income was $3,154,620,000. The value added by manufacturing was $1,541,681,000. The total 1956 crude oil refining capacity per day was rated at 1,823,250 barrels. The fuel used is primarily natural gas with some liquid petroleum gases and some coal and coke being used in the primary metal and foundry industries. Fuel oil is used as a standby fuel and is consumed in shipping and to a limited extent in some industrial processes. Most diesel fuel is consumed by railroads and ships. The 1957 motor vehicle registrations numbered 864,501 (all types), and these vehicles consumed an estimated 894,813,000 gallons of gasoline. Motor vehicles and other internal combustion-type prime movers contribute to the over-all air pollution load of the larger cities.

The air pollution problems are concentrated in the large industrial areas. Industrial emissions include odors and smoke, vapors, dust and fumes. The rural areas' problems were associated with rice dryers, cotton gins, cotton oil mills and insecticide plants.

Specific control ordinances on air pollution are absent in all the cities of this area. Limited control is exercised in some cities by the general nuisance laws or injunctive proceedings. Zoning laws limiting the location of certain types of industries are provided in some of the cities.

Houston

The largest population in the State is concentrated in Houston, (Harris County) approximately 50 miles inland from the Gulf of Mexico. Harris County also embraces the following incorporated cities: Pasadena, Galena Park, Jacinto City, South Houston, Deer Park, LaPorte, Baytown, Bellaire, West University Place, Southside Place and several other small incorporated towns. Houston surrounds most of these smaller cities. As of January 1, 1957, the City of Houston contained 353 square miles.

This area has had a very rapid population growth due to the location of industry along the deep-water channel that runs east-southeast from Houston Turning Basin, which is located about four miles southeast of downtown Houston. The estimated population of Houston, as of January 1, 1958, was 910,000 and that of Harris County was 1,195,000.

The City is the main distribution and trade center for the upper Gulf Coast of Texas and is highly industrialized. Houston accounted for one-quarter of the total value added by manufacturing in 1954 for the entire State. The value added by manufacturing in Harris County for the year 1954 was $868,747,000. The estimated non-agricultural employment, as of January 1, 1958, was 435,365, employed in 25,358 establishments.[47]

The larger industries are concentrated along a 35-mile strip on the north and south sides of the Houston Ship Channel. They produce many organic and inorganic compounds including: cement, lead, acid (nitric, sulfuric, hydrochloric, and hydrofluoric), fertilizers, petroleum products, petrochemicals, insecticides, ammonia, paper, paper pulp, iron, steel and tetraethyl lead.

As early as 1944, complaints due to industrial emissions had been received from local citizens along the Channel area. These complaints concerned damage to property and vegetation and discomfort to persons residing in the area, such as eye and throat irritations and other respiratory disturbances. Complaints are still received by the city and county health departments. In 1956 and 1957, 143 complaints of all types were received by the city health department.

With the prevailing southerly winds, the residential areas on the north side of the Houston Ship Channel areas frequently subjected to pollutants from various plants along the Channel. Occasionally, the winds will have an easterly to northeasterly component and during this period, pollutants discharged along the Houston Ship Channel are carried into the city. Northerly winds carry pollutants from the Channel into the residential areas to the south of the Channel. West winds occur infrequently.

Efforts have been made by certain industries along the Houston Ship Channel to abate discharge of pollutants to the atmosphere by installation of control equipment or process changes. Examples are: the conversion of hydrogen sulfide to elemental sulfur, spent sulfuric acid and acid sludges to white surfuric acid, reduction of sulfur dioxide emission from sulfuric acid plants by conversion of sulfur dioxide to ammonium sulfate, and further processing of waste hydrocarbons to useful products. However, continued effort must be applied to further reduce the atmospheric discharges to acceptable limits.

The total consumption of natural gas for 1957 in the metropolitan Houston area was 67,963,478 M.C.F.; this was distributed as follows: Domestic — 18,670,600 M. C. F.; Commercial — 6,747,105 M. C. F.; and Industrial—38,556,442 M. C. F. One distribution system had over 330,600 M. C. F. gas loss due to leaks in its system. (This does not include gas used by large plants who have direct pipeline connections.)

Considerable natural gas and liquid petroleum gases are used in petrochemical and petroleum refining operations. A large quantity of tail gases (hydrocarbons) and some sludge oils and other hydrocarbon wastes are burned. Some of these, however, are being converted to useful products. Great quantities of crude oil and petroleum products are stored in tanks in the area. Evaporation from these tanks contributes to the overall pollution problem.

Motor vehicle registration in Harris County for 1957 was 511,125, and these vehicles consumed an estimated 529,014,000 gallons of gasoline. The traffic survey by the Texas State Highway Department in 1953 states there were 2,216,929 vehicle and passenger trips made in and through the metropolitan area daily, of which 2,078,864 or 93 percent had both termini within the area.[48]

The City is served by five U.S. Highways, nine State Highways, five major railroads and the Houston Belt Terminal Railroad that serves the Port of Houston area. These railroads are now dieselized. Ships entering and leaving the Port of Houston for 1956 totaled 7,549, with a tonnage of 52,293,262 short tons. Approximately 55 motor and freight lines serve the City. There are seven major airlines serving the City of Houston; the Municipal Airport handled a total of 129,801 landings and departures in 1954. Fuel consumption from these sources contributes to the over-all air pollution in the area.

Refuse pickup is provided in all incorporated areas in the metropolitan Houston area twice per week in the residential areas and daily in the commercial areas. In addition, there are some private collectors who pick up refuse at business establishments in the City and unincorporated areas in the metropolitan area. Large industries along the Channel have their own refuse pickup and disposal sites. The city of Houston operates four large incinerators and one sanitary landfill. It is estimated that 500,000 tons of refuse were collected by the City of Houston in 1957; most of this was incinerated. Incorporated towns of Bellaire, South Houston, Jacinto City, Southside Place and West University Place use the sanitary landfill method for disposal. At Baytown, Pasadena and Galena Park, the refuse is burned with infrequent cover. Several other incorporated communities in the west section of Houston contract with the city of Bellaire to dispose of their refuse.

The city of Houston operates three large activated sludge-type sewage disposal plants and one fertilizer plant, which utilizes the sludge from two of these disposal plants. Complaints of odors from these sewage treatment plants have been received. Masking odors have been used with some success at the fertilizer plant. In addition, there are some 72 small sewage treatment plants of various sizes and types in areas annexed by the City since 1950 and approximately 40 others in the county. The sewage plants at Pasadena, Baytown and other towns in the county are included in this figure. All these are potential sources of odors in their immediate locality.

The city of Houston has in its City Code, Article XVIII, Nuisance Section 1014, a provision which applies indirectly to discharge of pollutants to the atmosphere. However, Harris County Health Department uses State Statutes on common law nuisances to attempt to bring about abatement of air pollution when cooperative means fail. The city of Houston has no zoning ordinance; business or industry may locate more or less where desired.

All air pollution matters in the county are referred to the Air and Stream Control Section, Harris County Health Department, for investigation and action. The Department investigates complaints and issues abatement notices. Pollen counts are made jointly each fall by the City of Houston and the Texas State Department of Health Laboratory at Houston.

A considerable number of radioactive sources are located in the City of Houston. The City has experienced two major spills in the past three years, which fortunately were confined to the immediate premises. The City of Houston Health Department makes regular periodic surveys of the installations using and handing radioactive isotopes in cooperation with the Texas State Department of Health and U. S. Atomic Energy Commission. The City Health Department also operates a high volume air sampling station for the National Air Sampling Network in cooperation with the U. S. Public Health Service.

Beaumont-Port Arthur (Jefferson County)

Jefferson County lies in extreme southeast Texas. The major cities are Beaumont and Port Arthur. The population growth has been rapid, as is indicated by Table 33.

TABLE 33
POPULATION GROWTH IN JEFFERSON COUNTY

Area	1940	1950	1957 Estimated
Beaumont	59,061	94,014	130,000*
Port Arthur	48,140	57,530	90,000*
Jefferson County	145,329	195,083	260,928

*Including suburbs.

The economy of the area is derived from agriculture (rice farming), livestock, oil and gas production, sulfur mining, petroleum refining, petrochemicals, lumbering, oil field equipment manufacturing, rice drying and milling, ship building, transportation, food processing, fisheries, calcined carbon and manufacturing. It is a trading and distribution center for the area.

Its chief industries are oil refining and petrochemical plants and related industries, such as acid manufacturing. The chief source of industrial air pollution complaints has been from the south edge of Beaumont, involving an acid production plant, a sulfur mining operation, a refinery, a rendering plant and a petrochemical plant. Complaints were due to gases, odors, fumes and dust which caused discomfort to the local residents and damage to their property, primarily paint discoloration.

In one fumigation incident by the local acid plant at Beaumont, the pupils of Lamar State College of Technology, located near the plant at Beaumont, had to be dismissed due to the irritation and choking effect on their respiratory systems. The central portion of the county has experienced fumigations with chlorine gas due to accidents at one of the plants.

Some improvements have been made to reduce sulfur dioxide emission from two refineries, one at Port Arthur and one at Beaumont; and one acid manufacturing plant in the latter city. In the Port Arthur refinery, an elemental sulfur plant has been installed to produce this product from hydrogen sulfide previously burned. In the Beaumont refinery, hydrogen sulfide gas is sold to an adjacent acid manufacturing plant where it is burned along with acid sludges from this and other refineries and some elemental sulfur to produce sulfuric acid. The acid manufacturing plant produces ammonium sulfate fertilizer from the sulfur dioxide in the tail gases of the acid manufacturing unit to reduce its sulfur dioxide emission. Hydrogen sulfide gas from the sulfur mining operation which had caused discoloration of the houses to the north of the field is now collected and treated by the sulfur mining company to prevent its escape to the atmosphere. However, two small oil producers on the dome do not attempt to control the escape of hydrogen sulfide.

A rendering plant in the south Beaumont area at times emits odors through improper operation of their cookers causing discomfort to the local citizens. Unpleasant odors escape from a feed additive plant and waste water lagoon of this plant, and are carried by the wind to the residential areas and the college to the northwest. Incineration and the use of odor-masking compounds are used to reduce these odor emissions. Also, complaints of dust from a bedding plant and smoke from a small lumber yard have been received.

The rice growers send their rice to commercial dryers for drying. Large quantities of heated air along with chaff and dust are discharged to the atmosphere from the dryers. This chaff and dust presents a nuisance problem due to irritation of the skin and also aggravates the respiratory systems of those having hayfever and asthma. Certain varieties of rice appear to cause more skin irritation than others. Some attempts have been made to abate these dust and chaff discharges, not only in this area, but also in other areas along the coast, by installation of scrubbers and settling chambers. The fisheries in the southern part of the county process menhaden fish for oil, meal and "stick water." The meal dust escaping to the atmosphere from the dryers liberates a nauseating odorous compound and odorous condensable and non-condensable gases are liberated from the "stick water." Dust collector systems and special evaporators with barometric condenser-legs have reduced these odorous emissions in the past two years. Earlier, odor complaints had been received from citizens living many miles from these plants.

Fuel usage for 1957 in thousand cubic feet was:

USE	CITY	
	Beaumont	Port Arthur
Residential	1,954,209	1,071,083
Commercial	553,073	233,714
Industrial	1,052,158	80,396
Public Authority	15,281	Unavailable
Total	3,575,261	1,385,193

The industrial figures do not indicate direct sales of gas to large refineries and petrochemical plants that have direct pipeline connections or who use waste hydrocarbon gas from manufacturing processes in the plant. This gas may also be used as raw or intermediate materials in processes.

Motor vehicles of all types in the county for 1957 numbered 107,929 and consumed an estimated 111,707,000 gallons of gasoline. Beaumont is served by seven Federal and State Highways, four major railroads, six inter-city and one intra-city bus line, air lines, eleven motor freight lines and inland and tidewater shipping lines. Port Arthur is served by six Federal and State roads, two major railroads, three inter-city and one intra-city bus lines, three airlines, motor freight lines and inter-coastal and tidewater shipping. In addition to this fuel usage, liquid petroleum gases, diesel and fuel oils are used by the motor freight lines, the railroads and boats that ply the Channel. The area is served by shipping through the Sabine-Neches Ship Channel. All these contribute to the over-all pollution in the county.

The two large cities (and some of the smaller cities) provide refuse collection. Beaumont collects its refuse twice a week in residential areas and daily in the commercial area. Beaumont has a disposal site two and one-half miles northeast of the City and uses landfill with occasional burning. Port Arthur's site is two miles south of the city, and the refuse is burned openly.

Beaumont has now in operation a new sewage disposal plant. Prior to the construction of this plant odors were present in the Turning Basin Area where the sewage was discharged, but this has been eliminated with the new plant. Port Arthur discharges raw sewage into the Sabine Ship Channel.

The cities in the counties have no air pollution control ordinances. Beaumont has a zoning ordinance which restricts location of industries. Air pollution complaints in Beaumont and Port Arthur are handled by the local city health departments and in the county by the county health department.

The county judge has a committee on air pollution, which is an advisory body. Members include representatives from local industries and private citizens. At first, it represented only the north half of the county, but the complete county is now represented on the committee. They meet once every three months, review complaints, hear interested parties and make recommendations to the county judge on what may be done to abate the problems. Some air pollution sampling has been done by local industries to study their problem.

Orange

Orange is located in Orange County. It derives its economy from rice growing, lumbering, livestock, oil and gas production, ship building, pipe manufacturing, petrochemicals and shipping.

The only air pollution complaints received were of smoke and odors from the burning dump and odors from the sewage treatment plant.

Primary fuel used in Orange is natural gas. The 1957 consumption was 761,532 M.C.F., distributed as follows: Residential—331,334 M.C.F.; Commercial—300,133 M.C.F.; Industrial—121,175 M.C.F.; Public Authority—8,890 M.C.F. Motor vehicle registration of all types for Orange County for 1957 was 22,686, with an estimated gasoline consumption of 23,480,000 gallons.

Refuse is collected by the city twice per week in residential areas, and daily in the business district and disposed of in the swampy area west of the city. Refuse is burned, and complaints are received under certain wind directions. The sewage treatment plant is located on the east side of the city. Odor complaints are received from its operations.

The large petrochemical plants are located west and south of town. No recent air pollution complaints had been received on their operations. Nitrous oxide fumes from an acid manufacturing operation, under certain meteorological conditions, occassionally descends to the road in front of the plant.

The city has no air pollution ordinance but has a zoning ordinance that restricts locations of industries. All complaints on air pollution are handled by the Orange City-County Health Department.

Galveston

The City of Galveston lies on an island just off the mainland. It derives its economy from shipping, sulfur and cotton export, fishing, shipbuilding, manufacturing and tourist trade.

The weather and topography are similar to that of Houston. Onshore breezes prevail except for occasional offshore breezes during the early morning hours in the warm months of the year. Calms endure longer on the mainland than on the island. On calm, clear nights, differences in temperature between the Post Office Weather Station (elevation 69') and the airport Weather Station (elevation 25') may be as much as six to eight degrees Fahrenheit and as much as tweny degrees Fahrenheit further inland.

The City has had no air pollution complaints; however, when the wind is from the Texas City area odors from plant operations in that area are perceptible. The prevailing winds are southeasterly and have a tendency to move pollutants away from the island. If a surface or low level inversion exists, smoke from prairie fires will be carried out to sea and back by local winds. Very little smoke is said to be emitted from ships when in port.

Natural gas is the primary fuel used. (See Table 34 for Texas City and Galveston.)

Refuse collection is twice per week in the residential areas and daily in the commercial area. The disposal site is located on the west end of the island, and open burning exists. The sewage treatment plant is located at this site also.

The City has a zoning ordinance which restricts location of industries and a clause regarding emissions to the atmosphere by industrial operations. An ordinance prohibits burning of trash in the city, except in approved-type incinerators. Air pollution complaints are handled through the City Health Department.

Texas City-La Marque

The two cities of Texas City and La Marque adjoin each other and are located on the mainland of Galveston County, north of the City of Galveston. They derive their economy from fishing, petroleum refineries, petrochemical plants, fertilizer plants and oil and gas production.

A hearing was held for the local citizens by the State Department of Health in 1952; an air pollution committee representing industry followed shortly. All complaints received by the Galveston County Health Department are turned over to this committee for action.

Air pollution complaints of odor, gases and fumes which have caused discomfort to the residents, damage to the paint on their homes and corrosion of the screens have been received by the local health department.

Hydrogen sulfide and acid fume emissions have been experienced in the area. Odors from the paper mill at Pasadena, 35 miles to the north, are occasionally received with winds out of that direction.

TABLE 34
1957 NATURAL GAS USAGE FOR SELECTED CITIES*

CITY	Domestic	Commercial	Industrial	TOTAL
Galveston	874,264	435,585	689,528	1,999,377
Texas City-La Marque	510,197	131,366	362,942	1,004,505

*In thousand cubic feet.

These figures do not indicate direct sale to or use of gas by large refineries and petrochemical plants that they have direct pipeline connections.

Natural gas is the primary fuel used in the city. (Table 34.) The 1957 motor vehicle registration numbered 53,797 and the gasoline usage was 55,679,393 gallons.

Refuse collection in Texas City is twice per week in the residential areas and daily in the business district. Collection is by private contract, and burning with daily cover disposal is used with sanitary landfill. Sites are located in the north part and west edge of the City. La Marque collection is by private collectors and is disposed of by burning in pits and covering when filled. The site is located on the west side of town. Local plants handle their own refuse which is usually burned or buried.

Texas City has a building code restricting location of industry but no ordinance on air pollution. La Marque has a zoning ordinance under study. Air pollution complaints are handled by the Galveston County Health Department.

Victoria

Victoria is located in Victoria County in the west end of the Coastal Prairie. The City derives its economy from agriculture (rice and cotton are the main crops), livestock, oil and gas production, oil field equipment and servicing, rice dryers and elevators, cotton ginning, cotton seed crushing and oil milling, insecticide blending, light manufacturing, petrochemical and petroleum refineries and aluminum smelting plants in the area.

Air pollution complaints have been received on dust and lint from cotton seed crushing and oil mills, the insecticide blending plant, the concrete mixing plant, odors from the rendering plant (operating now only as a receiving station for carcasses) and the city refuse disposal site. For the past six months, the disposal method has been a sanitary landfill due to an injunctive proceeding to abate discharge of pollutants to the atmosphere when the refuse was burned. A fish-like odor from a chemical plant located in the east end of the county is perceptible when the wind is out of the southeast and a surface-based temperature inversion exists.

The primary fuel used is natural gas. The 1957 consumption was 920,446 M.C.F., distributed as: Residential—573,006 M.C.F.; Commercial—285,062 M.C.F.; Industrial—62,384 M.C.F. Motor vehicle registration of all types in the county was 22,829, with an estimated fuel consumption of 23,628,000, most of which is gasoline.

Refuse is collected twice per week in the residential areas and daily in the business area and is disposed of by the sanitary landfill method. It is disposed of at a site three miles northwest of town. The sewage disposal plant is located one and one-half miles south of town. No odor complaints have been registered from either operation.

The city has no air pollution ordinance and no zoning ordinance. All complaints on air pollution are handled by the Victoria County Health Department.

Bay City

Bay City, in Matagorda County, derives its economy from agriculture, livestock and oil and gas production. Rice and cotton are the main agricultural crops.

Air pollution complaints have been received concerning odors from septic tanks, hog pens and chicken yards. Also complaints of dust, lint and smoke from the local cotton gins during ginning season, and dust and chaff from the rice dryers have been received.

Fuel is natural gas. Total usage in 1957 was 373,098 M.C.F. (90 percent residential and 10 percent commercial and industrial). Car registration in the county numbered 11,875 for 1957, with an estimated gasoline consumption of 12,271,000 gallons.

Refuse collection is provided twice per week in the residential areas and daily in the business area. Disposal is at a site two miles northwest of town. The refuse is burned in a trench and periodically covered. The sewage treatment plant is located two miles south of town. No odor complaints have been received from either operation.

The City has one air pollution control ordinance which restricts trash burning. No burning is allowed in the business area, and no trash burning after 5:00 p.m. is allowed in the residential areas. The Matagorda Branch of the Fort Bend-Matagorda-Jackson County Health Department receives and investigates air pollution complaints.

Air Pollution in Region I-B

The Rio Grande Plain lies south and southwest of the San Antonio River and Balcones Escarpment, extending to the Rio Grande on the west and the Gulf of Mexico on the south. This area is often referred to as the brush country due to its vegetation, consisting of mesquite, small oak, huisache and cactus. The elevation of this region ranges from sea level to approximately 900 feet, while the annual precipitation varies from 30 inches on the east to 20 inches on the west. The mean hourly wind speed is 12 m.p.h.; prevailing winds are from the Gulf (SSE-SE) all year. Calms average about ten percent and heavy fogs occur 24 days per year.

Most of this area, except for the Lower Rio Grande Valley and the Corpus Christi area, has a sparse rural population, providing a density of from 5 to 35 persons per square mile. The area is growing very slowly as indicated by the 1940 to 1950 change in population (Figure 4). Cattle ranching is the predominant livelihood for the populace, and very few industries are located in this area.

As indicated by the questionnaires, the only air pollution problems in the area, excepting Corpus Christi and the Lower Rio Grande Valley, were: odor and smoke from dumps—three; odors from sewage plants—three; lint and dust from cotton gins—two; dust and odor from a carbon black plant—one; and hydrogen sulfide from a gas cycling plant—one. There are, however, two centers of population in this region which tend to have community-wide problems; the Lower Rio Grande Valley and the Corpus Christi area. Each of these areas is therefore treated separately in the ensuing discussion.

Lower Rio Grande Valley

The two principal counties of the Lower Rio Grande Valley are Cameron and Hidalgo with the lower portion of Willacy County also included in this region. The area is fairly heavily populated; Cameron County has a population density of 141 persons per square mile and Hidalgo has 104 persons per square mile. Willacy County has only 35 persons per square mile, but these people are concentrated in the lower part of the county. The two principal counties showed over 50 percent increase in population from 1940 to 1950. Cameron grew from 83,202 to 125,170, while Hidalgo grew from 106,059 to 160,446. The 1957 estimated populations for Cameron and Hidalgo counties were 149,480 and 190,000 respectively; that of Willacy County was only 22,037. The population in the valley is approximately 60 percent urban, 20 percent non-farm rural and 20 percent farm rural.

This area has the most heavily concentrated agriculture in the State. A great stimulus was given to the agriculture and entire economy of the area in 1954 with the completion of Falcon Dam on the Rio Grande. There are about 635,000 acres of irrigated land in the valley which produce citrus fruit, winter vegetables and cotton.[10] The growing season is figured at 336 to 339 days by the Weather Bureau.

TABLE 35

TOTAL GAS SALES IN M. C. F.—YEAR 1956

CITY	Estimated 1956 POPULATION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TOTAL
Brownsville	43,000	268,797	189,235	1,217,748	1,675,780
Edinburg	15,000	73,337	70,734	73,877	217,948
Harlingen	33,000	242,843	300,524	342,518	885,885
McAllen	28,000	190,082	66,017	2,094	258,193
Mercedes	13,000	42,162	27,558	16,304	86,024
Mission	14,500	58,953	42,277	38,699	139,929
Raymondville	12,000	51,772	32,464	81,673	165,909
San Benito	15,600	82,294	49,026	19,854	151,174

As might be expected, the major industries are food processing plants and related industries. In addition, there are cotton gins, gas-chemical and insecticide plants, and clay products industries. The air pollution complaints in this area concerned lint, dust and smoke from gins; odors from citrus and vegetable wastes; odors from shrimp and fish packing; and careless use of insecticides resulting in fish kills in canals and sickness of farm laborers.

The fuel usage as usual is almost 100 percent gas, and even this fuel is used very little due to the warm climate and nature of the industries. The 1956 gas usage in eight of the larger cities of the valley is shown in Table 35.

The 1957 vehicle registrations for Cameron and Hidalgo Counties were 47,211 and 54,109 respectively. However, these figures do not reflect at all the large number of tourists who drive into that area, especially during the winter months. Also, Matamoros, Mexico, just across the border from Brownsville, provides city traffic unaccounted for by the registrations cited.

The valley is essentially very clean and free of debris and rubbish. Refuse is collected at periodic intervals and disposed of mainly by sanitary landfill. Although some burning at the disposal sites may occur, no problems are created due to the location of such sites. In all of the towns or cities, trash burning is either prohibited or at least strongly discouraged by local ordinances. No specific air pollution ordinances are in effect in this area, and the major activities of the local health departments regarding air pollution work involve investigation of complaints.

Corpus Christi

Corpus Christi, in Nueces County, is located on the Corpus Christi Bay on the Gulf of Mexico. The terrain is generally flat and the prevailing wind direction is south-southeast with a mean hourly speed of 12 m.p.h.[13]

Corpus Christi has had the most rapid population growth percentage-wise of any large Texas city from 1920 to 1957. The population was 57,301 in 1940 and 108,053 in 1950, indicating an 89 percent increase for that decade. The estimated population for January 1, 1958 was 175,000, and it is predicted to reach 290,000 by 1970 and 375,000 by 1980. In 1950, the county population was approximately 85 percent urban; ten percent non-farm rural; and five percent farm rural.

Nueces County is a leading petroleum and natural gas producer, and most of the employment is in these or related industries. Manufacturing in 1954 provided employment for 6,721 people and added a value of $71,593,000. The major industries in the area include: six oil refineries, one cement plant, one aluminum plant, one smelting and refining plant, two chemical plants, one large food products plant and one cotton gin. These industries are located on the north and west sides of the City, and since the prevailing wind direction is from the south-southeast, pollutants discharged to the atmosphere are generally carried away from the residential areas. However, complaints are still registered with the local health department due to odors and gases from the refineries, odors from the food products plant and particulate matter from the cement plant.

The 1957 natural gas usage in the City was estimated to be: Residential—703,000 M.C.F.; Commercial—3,500,000 M.C.F.; and Industrial—13,500,000 M.C.F. Vehicles in Nueces County, numbering 93,988, consumed an estimated 97 million gallons of gasoline in 1957. In addition, 1,780 dry cargo ships and 1,357 tankers moved in and out of the harbor during 1956, moving 15,568,864 tons of material.[9] No air pollution problems associated with fuel usage or transportation were indicated in this area; however, recognition must be given to the share which they contribute to the over-all pollution load of the atmosphere.

Refuse is collected three times weekly in the residential areas and daily in the commercial areas. It is disposed of by a sanitary landfill, located south of the city. Combustibles are burned occasionally, but this is restricted due to nearby residential areas. Backyard incinerators are discouraged by an ordinance in the Fire Department requiring approval of all incinerators. Also all trash burning in streets and alleys is prohibited. Odor complaints from the City's sewage treatment plants are fairly frequent, but this problem is currently being corrected.

Corpus Christi cooperated in the National Air Sampling Network in 1957. Before that the mayor of Corpus Christi appointed an advisory committee on air pollution in November, 1954. This committee has worked, with the assistance of the Texas State Department of Health, in combating air pollution problems. There are no air pollution ordinances in the City, and the local health department limits its activity to receiving and investigating complaints.

Air Pollution in Region I-C

This region, composed of the Pine Woods Belt, the Post Oak Belt and the Blackland Prairies, extends from the Louisiana border westward to the Balcones Escarpment, and from the Red River southward to the Coastal Prairies and the San Antonio River. This area is characterized by a climate intermediate between the humid maritime conditions along the coast and the continental conditions of the great inland prairies. Days of heavy fog vary from 17 to 21 days in the northern portion to seven to ten days in the southern portion. Calms occur over this area about 20 percent of the time. The mean wind speed ranges from 9.6 m.p.h. in the south to 12 m.p.h. in the north. Generally, the balance of climatic conditions is favorable for the dispersion of pollutants.

The Blacklands along the Balcones Escarpment (along with the coastal cities) contain the majority of the State's metropolitan population. The major cities in this area include Dallas, Fort Worth, Waco, Austin, and San Antonio. The remaining portions of this region are predominantly rural. The population of the area is fairly stable, but many counties are losing population (Figure 4). Agriculture, mainly crop farming but with increasing livestock production, is the basic industry in the rural area; the lumber industry also contributes. Manufacturing, however, is generally limited to food products and other industries related to agriculture. Twenty-five small cities were visited in this area, but the nature and magniture of their air pollution problem, as indicated by the health officers, did not warrant a separate discussion. A summary of these cities, their size in 1950, and the complaints reported in each are shown in Table 36.

Cotton gins were a major source of complaint; however, odors from sewage plants and smoke and odor from dumps were also quite frequent. A number of miscellaneous other problems were also indicated.

Dallas

Dallas, the county seat of Dallas County, is located in the Blacklands of North Central Texas. It is Texas' second ranking city in population

TABLE 36

COMPLAINTS REPORTED IN VISITED CITIES OF REGION I-C

CITY	1950 POPULATION	SOURCES OF COMPLAINTS
Gainesville	11,246	Dump and sewage plant
Denison	17,504	Wood preserving company
Sherman	20,150	Alfalfa dehydration plant
Paris	21,643	Gins, 3 rendering plants, 2 cotton oil mills
Texarkana	24,753	Fertilizer plant
McKinney	10,560	Gins, sewage plant, dump
Greenville	14,727	Gins
Longview	24,502	Refinery effluent runs through town
Marshall	22,327	Sewage plant
Waxahachie	11,204	Gins, sewer line
Cleburne	12,905	Gins, sewage plant, lime plant
Tyler	38,968	Fertilizer plant, asphalt mix plant
Corsicana	19,211	Gins, rockwool plant
Nacogdoches	12,324	Fertilizer plant, odors from paper mill in adjacent county
Huntsville	9,820	Sewage plant
Temple	25,467	Gins, rendering plant, feed mill
Taylor	9,071	Gins, sewage plant
San Marcos	9,980	None
New Braunfels	12,210	None
Seguin	9,733	None
Kilgore	9,638	None
Bryan	18,102	None
Lufkin	15,135	None
Palestine	12,503	None
Denton	21,372	None

and commercial importance.

Dallas County and Tarrant County, separate but contiguous standard metropolitan areas, had a combined population of 1,358,900, as of January, 1957, up 39.3 percent over the 1950 census total of 976,052. The population concentration within this metropolitan complex is the largest in the South or Southwest and the largest in the nation not on a navigable waterway.

The population of the metropolitan area (Dallas County) in 1957 was 827,500 persons, with a density of 926.6 persons per square mile, while that of the city was 621,500 persons. The city population showed an increase of 43 percent over the 1950 census total of 434,462 (which ranked the City 22nd in the nation).

The Bureau of Business Research, The University of Texas, has prepared the following population projections (Table 37):

TABLE 37

POPULATION PROJECTION FOR DALLAS (CITY AND COUNTY)

Year	Dallas County	City of Dallas	Outside City of Dallas
1950	614,799	434,462	180,337
1960	928,800	650,000	278,800
1975	1,336,300	935,400	400,900
2000	2,440,300	1,586,200	854,100

Total employment in Dallas County increased from 155,469 in April 1940, to 345,300 in August 1957, an increase of 122 percent (Table 38).

Employment by major groups as of August 1957, was:

TABLE 38

EMPLOYMENT IN DALLAS COUNTY

August 1957

INDUSTRY	EMPLOYMENT
TOTAL	345,300
Manufacturing	91,875
Non-Manufacturing	253,425
Construction	23,500
Transportation and Communications	23,905
Wholesale Trade	21,450
Retail Trade	66,680
Finance-Insurance-Real Estate	25,210
Services	30,330
Professional	23,915

Dallas is the regional sales, service, and administrative center for this area. Of the 1,000 largest manufacturers in the nation, based on assets, 193 have a Southwest Regional Office in Dallas. Many others have district or local sales offices. This City is also the largest wholesale center of the Southwest, and ranks fourteenth nationally in sales. Retail trade in 1954 increased 56 percent over the previous 1947 census, the largest increase experienced by any billion dollar market in the nation. Retail sales had an additional distinction of having the second highest average "per family retail sales" of the nation's 25 largest retail markets.

Dallas' manufacturing employment increased 93 percent between the census years 1947 and 1954, compared with 13 percent nationally. For 1954, the census tabulated the value added by manufacture in Dallas to be $506,943,000, up 112 percent over 1947. As of August 1957, Dallas had 1,829 manufacturing establishments employing an estimated 91,875 persons. Major industries in order of importance employment-wise were: Aircraft—26,545; Food Processing—10,800; Apparel—8,260; Electrical and Electronics Equipment—7,560; Non-Electrical Machinery—7,255; Printing and Publishing—5,730; and Fabricated Metal Products—5,135.

The majority of the industry is located on the northwest side of the city along the Trinity River. However, the newest industrial area is being developed northeast of the city. The residential expansion of the city is predominantly in the south, although construction of new homes is scattered throughout the area.

Fertilizer and cement plants near U. S. Highway 77, northwest of town, were reported to be the source of many complaints. It was indicated that dust from certain operations of these industries had reached sufficiently high concentrations along the highway as to cause greatly reduced visibility, thus restricting the flow of traffic and possibly creating hazardous driving conditions. Located near the sewage treatment plant in the southern part of town are a rendering plant and two lead plants. Odors from the rendering plant were very noticeable, but few complaints had been received due to the remote location. Some years ago, the lead plants had been accused of poor operations which allegedly resulted in deaths to animals and one person. No recent complaints have been received due to these operations. Other minor complaints involved blowing sawdust from a wood box factory and odors from the wastes of a de-inking paper plant.

The predominant fuel usage, natural gas, was distributed in 1957 as follows: Residential—16,188,359 M.C.F.; Commercial—3,549,049 M.C.F.; and Industrial—15,436,736 M.C.F.

A traffic survey was made of the metropolitan area in 1950 and 1951.[40] The Metropolitan Area, as selected for the survey, contained approximately 215 square miles and included 84 percent of the total county population. There were a total of 258,179 motor vehicles registered in 1950 of which 208,499 or 81 percent were passenger cars. There was a total of 1,349,538 vehicle and passenger trips in and through the metropolitan area daily, only 117,467 of which had one or both termini outside of the area. The 1957 vehicle registration for the county was 404,068 or 57 percent increase over 1950. These vehicles consumed an estimated 420 million gallons of gas.

Refuse is disposed of by the sanitary landfill method. There are several sites located around the City and occasionally tree limbs are burned at these sites. These landfill operations were very efficient and well organized, and no complaints had been registered due to odors or smoke. The sewage of the city is treated in a large 50 M.G.D., trickling filter plant. No odor problems were encountered from this source.

Dallas cooperated in the National Air Sampling Network in 1957, and they are continuing the operations currently. Dustfall samples were collected for a short time by the local health department, but these have been discontinued. The major activity of the health department in air pollution involves investigation of complaints. The City has a smoke ordinance regulating air pollution which delegated administrative and enforcement authority to the building inspector. This is discussed further under "Air Pollution Ordinances and Control Programs." However, it is felt that in view of the increasingly rapid growth of the City and the responsibilities and duties already placed with the building inspector, the present air pollution program should be broadened or made a separate entity to provide the activity necessary for abating air pollution problems in the future.

Fort Worth

Fort Worth is often referred to as the point "Where the West Begins." It is a rapidly growing city and an outstanding national livestock and grain market. In general, the industry in Fort Worth is founded on specialized products such as food, clothing, household supplies and furnishings, printed material, electrical equipment, and other consumer goods. Fort Worth, along with Dallas, is among the leading centers for the manufacture of aircraft frames and parts. It is also a major center for the production of air conditioning equipment.

The 1950 population of Fort Worth was 273,778, an increase of 56.9 percent over the 1940 census of 177,662. The county population in 1950 was 361,253. It was estimated that the City has grown to 370,000 by 1957, while the metropolitan area contained 532,000 people. The 1970 estimate for Fort Worth is 430,000.

Manufacturing in 1954 employed 48,367 people and added a value of $368,152,000. The aircraft industry employed 45 percent of these people and added a value of $157,466,000 or 43 percent of the total.

The manufacturing industries were cause for only a few complaints. The more recent complaints involved five dust problems from grain elevators, oil mills and grain-milling operations; an odor problem from chemical plants; and dust and smoke from a foundry and steel company.

The major fuel consumed in the city, natural gas, was used as follows in 1957: Residential—9,580,049 M.C.F.; Commercial—2,027,155 M.C.F.; Industrial—9,517,463 M.C.F.; and Public Authority—563,799 M.C.F. The vehicle registration in the county for 1957 was 246,417, and these vehicles consumed an estimated 253 million gallons of gas.

Refuse is collected by the City and disposed of primarily in open dumps around the City. However, city incinerators are in use, and a small portion of the refuse is covered in a sanitary landfill. County dumps northeast of the City have created quite a smoke and odor problem, and citizens are currently voicing complaints. Burning of leaves is allowed in the City, but other trash burning is restricted. There are no ordinances relating to air pollution in the City. Fort Worth is currently cooperating in the National Air Sampling Network, but no other sampling work is carried out. The local health department has undertaken some work in the air pollution field in complaint investigation.

Austin

Austin, the capital city of Texas, is located in Travis County on the Colorado River. The county population was 160,980 in 1950, was estimated to be 224,037 in 1957, and is predicted to reach 541,302 by 1975. The county population in 1950 was 85 percent urban, 10 percent non-farm rural, and 5 percent farm rural. The city population was 132,459 in 1950 and estimated to be 186,000 in 1957.

Austin is primarily a civic rather than an industrial city. The employment in 1955 totaled 71,028, with medical and professional employees contributing 18 percent and governmental employees 12 percent of the total while manufacturing employees added only 6 percent.

There were only seven industries in 1954 with over 100 employees. Three of these were classed as food, two as paper products and one each as leather goods and furniture. Only one recent complaint originated with the manufacturing industries. A wood products plant on the north side of the city had difficulties with incinerating their wood wastes. For a short period, smoke and odor caused complaints from the nearby residents. This situation has been corrected. Other minor complaints involve odor from a Fiberglas boat plant, and an insecticide plant, and dust from the rock-crushing operation of an aggregate plant.

Refuse is collected daily in the commercial area and twice weekly in the residential areas and then covered in a sanitary landfill. No problems were encountered from this operation. County dumps around Austin emit smoke and odor, but no complaints had been registered. The city has an ordinance against "backyard incineration" and very few problems were reported from this source. The sewage plant located on the east side of town was not reported to have caused any odor complaints. However, a new school site is planned only a short distance north and east of the plant; due to the prevailing south winds, this will require efficient operation of the plant to avoid an odor problem.

The Austin-Travis County Health Department is cooperating in the National Air Sampling Network in 1958, but no other sampling work is being conducted. The local health department's main work in air pollution concerns receiving and investigating complaints.

Waco

Waco is a growing metropolitan area. In 1940 it has a population of 55,982; in 1950 it had increased to 84,706. The 1957 estimate was 110,000 for the city and 157,720 for McLennan County. Although a marked transition to an industrial economy has occurred and is occurring, the economic life and growth of Waco are basically supported by agriculture in McLennan and other nearby counties. In 1954, farm incomes represented 20 percent of the total income of Waco and its immediate area. Waco ranks sixth industrially among Texas cities, having 254 manufacturing establishments of all sizes engaged in the manufacture and distribution of a large variety of products. These firms employ more than 8,650 persons. Included among the larger Waco factories are: a chemical insecticide plant, a cement plant, a textile mill, a woodworking plant, a tire manufacturing plant, a glass container and carbon fabricating plant, and three food industries. Problems associated with industrial activity were few. A cement plant about seven miles from town was reported to emit large quantities of dust, which affected the vegetation on a nearby ranch. There are no residential areas in the vicinity, so no complaints besides that of the rancher were received. A few of the industries in the City occasionally burn scrap material which causes dense smoke, but no complaints had been received. Only one gin and one cotton oil mill are located within city limits, but these industries had not created any noticeable problems. However, a cottonseed delinting plant had caused complaints due to dust emission.

The natural gas usage in the city was: Residential—2,117,996 M. C. F.; Commercial—465,421 M. C. F.; Industrial—2,991,999 M. C. F.; and

Public Authority—69,678 M. C. F. The 1957 vehicle registrations totaled 64,009, and these vehicles consumed an estimated 66 million gallons of gasoline. An Origin and Destination Survey of Waco made in 1952 showed that 82 percent of the daily (24 hour) vehicle traffic that passed through external interview stations had origins or destinations in Waco.[50] Of these 52,280 vehicles, 14,374 or 28 percent, had origins or destinations in the central business district.

Refuse is handled in a variety of ways, but most of the waste is burned in incinerators. However, a dump is used to burn tree limbs, and a landfill on the north side of town is used for portions of the refuse. No complaints had been filed due to either the refuse disposal operations or the sewage treatment operations.

The City has no controls or ordinances pertaining to air pollution, and the air pollution activities of the local health department are limited mainly to investigation of complaints. The City started cooperating in the National Air Sampling Network in January 1958, and this is to continue throughout the year.

San Antonio

San Antonio, county seat of Bexar County, is one of the most distinctive cities in the United States. San Antonio has enjoyed rapid expansion but has succeeded in preserving most of its places of historic interest such as the Alamo, the missions and others. The 1957 estimate of the city population was 545,000, while the metropolitan area estimate was 605,000. The City population estimates for the future are: 602,860 in 1960; 889,321 in 1970; and 1,098,311 in 1975. Military personnel in the area, but outside the city, totaled 23,613 in 1955. The county population in 1950 was 89.8 percent urban, 7.7 percent non-farm rural and 2.5 percent farm rural. The population density was 570 per square mile.

The economy of the area is varied. This is one of the most important military centers in the world and includes Fort Sam Houston, Randolph Air Force Base, Lackland Air Force Base, and other installations. It is estimated that 33,000 civilians are employed at these nearby military bases. Tourists visiting this historic City are estimated to add 40 million dollars in trade annually. The 1954 manufacturing employment totaled 17,894 people, and the value added by manufacturing was $111,139,000. According to the 1954 census, there were 44 establishments employing 100 or more people. The classes of these 44 establishments were: nineteen food, ten apparel, four paper products, four fabricated metal, two primary metal and one each of tobacco, textiles, wood products, machinery and stone, shell and glass. The city has tended to encourage only the location of "cleaner" industries in the area such as fabricators, light manufacturing, research and development. However, the planning department is faced with a problem common to many cities with rapid increases in population. The industries were originally well outside the city limits but now, due to expanding residential areas, are located on the fringe of the city limits quite near residential zones. Cement plants are located on the north edge of the city, a pecan charring plant on the east, rendering plants and stockyards on the south. The major recent complaints concerned dust from one of the cement plants, odors from one of the rendering plants, and smoke from an asphalt roofing plant.

The predominate fuel used is natural gas. The usage for 1957 was distributed as follows: Domestic—7,890,445 M.C.F.; Commercial and Industrial — 10,067,960 M.C.F.; Public Authority — 3,789,355 M.C.F.; and Power Plants—16,282,817 M.C.F. The estimated liquid petroleum gas consumption in the county totaled 2,440,000 gallons of which 2,000,000 gallons were used in the suburban areas. A traffic survey of the metropolitan area was made in 1955.[51] Bexar County had a total registration of 229,973 vehicles in 1955. These vehicles consumed an estimated 238 million gallons of gas. This was an increase of 38.7 percent over 1950 registrations. There was a total of 1,287,034 vehicle and passenger trips made in and through the metropolitan area daily, of which 1,219,817 or 94.8 percent had both termini within the area. Although fuel consumption both in heating and transportation is great, it has not been a source of problems to date. However, their contribution to the overall air pollution of the area is considered to be of material significance.

The primary refuse disposal is by sanitary landfill. This has created no air pollution problems. However, several open dumps are located in the county outside the city limits and have caused minor nuisance complaints. The sewage plant is located in the south end of town, but no complaints had been registered due to its operation.

San Antonio cooperated in the National Air Sampling Network in 1957, but no other sampling work is being conducted by the local health department. The major activity in air pollution is to receive and investigate complaints.

Air Pollution in Region II

This area extends from the Blacklands to the foot of the High Plains and from the Red River to the Colorado. Elevation varies from 1,000 to 2,500 feet and rainfall ranges from 30 inches in the east to 20 inches in the west. The prevailing wind direction is southerly with an average speed of 11.4 m.p.h. at Wichita Falls in the north and 13.3 m.p.h. at Abilene in the south. High-level inversions characteristic of the Gulf Coastal Plains are not frequent in this area and heavy fog is fairly infrequent. Generally, conditions for the dispersion of pollutants in this area appear to be favorable.

The population density in this area is only about 10 to 25 persons per square mile. As indicated earlier, most of the counties in this region are either losing population or gaining at a very slow rate. The two large cities, Wichita Falls and Abilene, account for a large percent of the total population in this area, and as would be expected, the counties containing these larger cities are growing at a much greater rate than the rest of the area.

The economy of this area is dependent largely upon livestock and crop production, and the major air pollution problems are associated with this livelihood. Cotton ginning caused lint, dust, and/or smoke problems in 21 of the 55 counties in this area. Miscellaneous other problems included: dust and odor from carbon black plants; odors from sewage disposal plants, rendering plants, abbatoirs and chicken dressing plants; dust from talc production; and odors and gases from the production of oil.

The towns of Brownwood, Snyder, Sweetwater, and Vernon were visited. Brownwood had received complaints concerning smoke and odors from car bodies burned in wrecking yards, dust from grain handling operations, and dust from rock-crushing operations. Sweetwater's complaint's concerned odors from the sewage lift station, smoke and odor from cotton gins when they were permitted to burn trash, and smoke and odor from the burning of domestic trash. Snyder's only complaint concerned dust and lint from a local gin. Vernon received occasional complaints of odors from garbage cans.

There are two large cities in this region with over 50,000 population, Wichita Falls and Abilene.

Wichita Falls

Wichita Falls, the county seat of Wichita County, is the financial market and general commercial center for a number of counties in North Central Texas and Southern Oklahoma. The county, bordering Oklahoma at the Red River, is a top-bracket county in population, wealth and production of crops, livestock, oil and manufacturing products.

In 1954, there were 101 manufacturing establishments employing 3,015 people; the value added by manufacturing was $26,350,000.[25] The major industries include oil refining, oil field machinery, garments, leather goods, flour, feedstuffs and foundry products. Crude petroleum and natural gas production is a leading industry providing employment for about 4,000 people (1957).

The only complaints concerning industry included rendering plant odors and smoke from the burning at refinery sludge pits, which caused discomfort to local citizens.

The 1957 natural gas usage in the city was: Residential—2,038,293 M.C.F.; Commercial—553,083 M.C.F.; Industrial—2,406,529 M.C.F.; Public Authority—79,469 M.C.F. No complaints were evident from the use of natural gas, but fuel oil usage in some heating plants caused occasional smoke problems. No figures on fuel oil consumption were available.

The motor vehicle registration for Wichita County was 58,326 in 1956.[25] These vehicles consumed an estimated 60 million gallons. An Origin and Destination Survey, made of Wichita Falls in 1954,[52] showed that of the 62,620 vehicles with external origins and/or destinations, 85 percent (53,350) were "local" movements and 15 percent (9,270) were "through" movements. These figures were for a 24-hour volume. Also, 41 percent (21,994) of the 53,350 local movements were destined for the central business district. Although no direct air pollution complaints have resulted from this source cognizance must be taken of its contribution to the over-all pollution load of the metropolitan area.

Residential refuse, garbage and rubbish is collected twice weekly and disposed of by open burning about three miles northwest of the center of town. The burning is normally done at night. Northerly winds occasionally blow the smoke and odor toward the city causing some complaints. Backyard incineration is discouraged by requiring approval of all incinerators. Only about six commercial incinerators are in use in the city, and these are not believed to contribute materially to the pollution of the area. The sewage disposal plant northeast of town created minor odor problems which resulted in complaints from the nearby residents. Plans currently being undertaken to alleviate the situation include the additional use of the old treatment plant which is located nearby.

The local health department handles all air pollution complaints, but there are no controls and no organized air pollution activities in the city.

Abilene

Abilene is located in Taylor County in the Low Rolling Plains of Texas. The City has grown rapidly in recent years. The City population in 1940 was 26,610, while in 1950 it was 45,570, a 71.2 percent increase. The 1957 estimate was 67,600, and the Abilene Chamber of Commerce predicts 102,000 by 1970.

The employment in the county in 1950 for the three basic industries was: Agriculture—1,760; Mining (Petroleum) — 1,294; Manufacturing — 2,377.[53] The industrial area is located generally on the east side of the city. The industries include cotton gins, a cottonseed oil mill, a soap works and a meat packing plant.

Complaints have arisen mainly due to dust and lint from the cotton gins during ginning season. However, some odor problems have been created by the waste pits of the cotton oil mill.

The gas usage for 1957 was as follows: Residential—1,539,703 M.C.F.; Commercial—368,609 M.C.F.; Industrial — 2,322,834 M.C.F.; Public Authority—50,892 M.C.F. No problems were attributed to this source. The motor vehicle registrations in Taylor County for 1957 were 41,729. These vehicles consumed an estimated 43 million gallons of gasoline. The city is served by four railroads (all diesel-powered), four Federal highways and two State highways. Although transportation sources contribute to the pollution of the area, these do not appear to constitute a significant problem.

Refuse is disposed of on a landfill where efficient operations have served to keep problems to a minimum. In addition to the landfill, a dump northeast of town is used to dispose of tree limbs and many other large combustibles and serves as a stand-by. This was not reported to have caused any problems. Wrecking yards, burning automobile bodies and similar operations have created some smoke complaints in localized areas. A local ordinance prevents trash burning in the streets and alleys, but refuse can be burned in an approved-type incinerator.

The local health department restricts its operations to complaint investigation and has indicated that it receives very few complaints.

Air Pollution in Region III

This region follows the general outline of the Texas section of the Great Western Plains. The topography of this region has been previously described and for the most part is flat with drainage canyons cutting into its edges. Its elevation varies from 2,500 to 4,500 feet, with an abrupt escarpment on its edges, varying from 100 to 1,000 feet.

Prevailing winds are south and southwest with average wind speeds varying from 9 m.p.h. in the southern portion to 14 m.p.h. in the north and central portions. Wind speeds are characteristically high and calms occur only six percent of the time. Fog and drizzles occur in winter and spring months but usually clear by noon. Some snowfall is experienced. Rapid and large temperature changes are experienced, especially during the winter months, when cold fronts move through from the Rockies and Plains states. Nocturnal inversions of the radiation type are frequent but break up by noon. The wind pattern, which disperses pollutants readily, is also instrumental in great dust storms that plague this area. The flat terrain and wind movement lends itself to dispersion of pollutants by natural ventilation.

The region has a population of 585,552.[3] The population is concentrated in the county seats of the 43 counties which comprise this area. Lubbock and Potter-Randall (Amarillo) counties have the highest population densities with about 100 persons per square mile. The remaining portion of the High Plains area has a density varying from 10 to 50 persons per square mile while the Edwards Plateau generally contains less than 10 persons per square mile. A comparison of the 1940 and 1950 census revealed that three areas in Region III experienced most of the population growth in this period. They were the areas around Amarillo, Lubbock, Odessa, and Midland.

The economy of this region is varied. Around Amarillo in the northern Panhandle, wheat production and cattle raising predominate, and the related manufacturing industries such as flour milling, feed production, meat packing, and rendering are numerous. Gray and Hutchinson counties, northwest of Amarillo, have a large oil and gas production with related oil refining and carbon black production. The Lubbock area, including about 15 or 20 nearby counties, is one of the world's most productive cotton growing areas. The industries in this area are generally related to cotton production and processing. Cotton gins, cottonseed crushing and oil mills, cottonseed delinting plants, and related equipment manufacturing predominate. On the border line between the High Plains and the Edwards Plateau oil production is the leading industry with cattle production following. Ector county was the second ranking oil producer of Texas in 1956. The main industries are oil refineries, carbon black plants, and sulfur recovery plants. However, large scale ranching in this area produces many cattle and sheep which support the related meat packing, rendering, and wool processing plants. The remaining portion of the Edwards Plateau is very sparsely populated and the only major livelihood is derived from sheep and goat raising.

The main air pollution problems of this region concerned cotton ginning, oil production and refining, and meat processing. Cotton ginning operations caused several widespread complaints, as indicated both by questionnaire and field visit, due to dust, lint, and smoke. The effect was discomfort to persons residing in the nearby vicinity of these operations. Oil production and refining, especially in the Odessa-Midland area, had been reported to create odor problems due to hydrogen sulfide emissions. No property damage, i.e., discoloration of paint, was indicated but it may pose a potential problem due to the encroachment of residential areas upon the oil fields. Meat packing and rendering plants created odor problems in localized areas but these were not considered of major importance. A few complaints also had been registered due to odors from sewage plants and open dumps.

Three cities in this area are treated separately in the ensuing discussion; the remaining cities, which were visited, are listed along with the 1950 population and the air pollution problems indicated in their respective jurisdictions (Table 39).

Amarillo

Amarillo is located in the approximate center of the Panhandle of Texas. It is the banking, distribution and commercial center for the Panhandle area. The City is situated on an almost level, treeless plain, and it lies both in Potter and Randall Counties. About 89 percent of the two counties' population of 87,140 was in Amarillo proper in 1950. Farming and ranching are carried on in the surrounding area.

The manufacturing value of Potter County for 1957 was $24,586,000 and Randall County was

TABLE 39

COMPLAINTS REPORTED IN SELECTED VISITED CITIES OF REGION III[10]

CITY	POPULATION	SOURCES OF COMPLAINTS
San Angelo	52,093	None
Odessa	29,495	Hydrogen sulfide from oil field
Midland	21,713	Feather dust (drilling mud manufacturing), stockyards
Big Spring	17,286	Gins, hydrogen sulfide from refinery
Pampa	16,583	None
Del Rio	14,211	None
Plainview	14,044	Gins, animal pens, rendering plant
Lamesa	10,704	Gins, sewage lagoons, meat packing plant

$187,000.[10] The major industries are a zinc smelter located just northwest and outside of the city limits; flour and feed mills, stockyards, meat packing plants and a refinery located at the east edge of the city. These are potential air pollution sources, but no complaints had been registered.

Major fuel used in this area is natural gas. In 1953, a total of 13,600,828 M.C.F. (thousand cubic feet)[51] was used and distributed as follows: Domestic—3,435,026 M.C.F.; Commercial—1,509,600 M.C.F.; Industrial—8,441,624 M.C.F.; and Other—214,578 M.C.F. Consumption of other fuels is unknown but is relatively low. Electric power is obtained from a power generating plant located just east of the city. It uses natural gas for fuel with fuel oil stand-by; in 1955 it had a fuel consumption of 4,526,000 M.C.F.[11]

Refuse disposal is by two semi-landfills, one located in the southeast section of the city and one at the municipal park in the north section of the city, and an open burning dump located to the northeast just outside of the city limits. The semi-landfill refuse disposal sites are being used to reclaim marginal land. No complaints have been registered against the burning dump. Refuse collection is tri-weekly in the residential area and daily in the business section; this tends to discourage backyard incineration of refuse.

The sewage treatment plant is approximately eight miles north of the center of the city, and no odors were evident at the time of the visit.

The 1957 motor vehicle registration of all types in Potter and Randall Counties was 64,783[15] with an estimated consumption of 67,456,000 gallons of gasoline. No estimate of traffic flow in and out of the city was avilable. In addition to automotive exhaust, there are exhaust fumes from three railroads, four airlines, twenty-four truck lines and five bus lines that serve the City. Four major U.S. Highways serve the City. Amarillo Air Force Base is located here.

Dust storms are experienced in the area. For the dry year—1956, there were 44 days in which blowing dust reduced visibility to less than three miles, while for the wet year—1957, 24 such days were reported.

No complaints on air pollution have been received by the city government or the Amarillo City-County Health Department, and the city has no ordinances covering air pollution.

Borger

Borger is located just south of the Canadian River Canyon and lies on the broad flat area of the Great Western Plains in the south end of Hutchison County. The topography and climatic conditions appear favorable for dispersion of atmospheric pollutants. Approximately two-fifths of the 31,580 population of the county reside in

Borger. The estimated 1957 population is 22,164.

The major industries are two carbon black plants and a synthetic rubber plant located on the west side of the city. Smoke and dust from the carbon black plants are so dense and voluminous that it can be seen from Amarillo, 40 miles distant. The houses and other buildings in the city were smudgy and black, vegetation was covered with oily carbon black and even animals were dark. Also, there were strong odors of gases throughout the area. These industries support the town so no formal complaints had been received. The attitude of the city public was reported to be that nothing much could be done to control this situation.

Principal fuel used in the area is natural gas. Domestic natural gas consumption for 1956 was 484,475 M.C.F. No figures were available on commercial, industrial and other users. Motor vehicle registration of all types in the county for 1957 was 20,974. Estimated gasoline consumption was 21,708,000 gallons.

Refuse is disposed of in an open dump located east of town but no complaints have been received on its operation. Trash is picked up twice per week in the residential area and daily in the business area, and there is an ordinance against trash burning in the city that discourages backyard incineration of refuse. The sewage treatment plant is located just west of the main business section but no complaints have been received by local officials concerning odors.

Any complaints on air pollution would be handled by the local health department.

Lubbock

Lubbock is the largest Texas city in the High Plains area of Texas. It is located in Lubbock County at the confluence of the Yellow House River and Double Mountain Fork of the Brazos River. The Caprock Escarpment begins just southeast of town. Yellow House Canyon transverses the northeast section of the city.

The population of Lubbock in 1950 was 71,747, while the county population was 101,048. The 1958 estimated population is 139,682 for the city and 170,179 for the metropolitan area.[55]

The city's main economy is derived from the surrounding agricultural and cattle industry, with cotton and grain the chief crops. Oil, wholesale and retail trade and manufacturing also support its economy.

There are 248 manufacturing plants employing 4,475 persons. There are five cotton gins (one just outside of the northwest city limits), two seed delinting plants, two grain elevators and one road asphalt mixing plant. Air pollution complaints have been received by the local health department. These complaints concerned dust, lint and smoke from cotton gins and cotton oil mills; odors and fumes from an acid cottonseed delinting plant had been noted as contributing to poor visibility which resulted in several highway accidents in the vicinity of the plant. Odors from putrification of manure in cattle and hog feeding lots and odors from a laundry were also reported. An oil field is located on the east edge of town, but no odor complaints have been received concerning it.

Natural gas is the primary fuel used in the area. Some liquid petroleum gas and oils are used. Natural gas consumption for 1957 was 500,920 M.C.F., distributed as: Domestic—266,109 M.C.F.; Commercial—110,518 M.C.F.; Industrial—104,915 M.C.F.; and Public Authority—19,428 M.C.F. Electric power is supplied by city owned utilities. The city is served by two airlines, two railroads, thirteen motor freght lines, six freight forwarding companies, bus lines and eleven common carrier motor freight lines. Motor vehicle registration of all types in Lubbock County for 1957 was 66,420 with an estimated gasoline consumption of 68,740,000 gallons per year. Exhaust fumes from these sources contribute to the over-all pollution of the atmosphere in the city.

Refuse is picked up twice per week in the residential area and daily in the commercial area. A burn and fill method of disposal is practiced at a sparsely settled site approximately three and one-half miles southeast of the City Hall. No complaints have been received on smoke or odors from this method of disposal. This City does not currently permit local incineration, but it is considering permitting incineration in backyard-type units. The sewage plant is located just north of the dump ground, and only one odor complaint has been registered against it.

The City has no ordinance on air pollution but it does have a zoning ordinance. All air pollution complaints are referred to the Lubbock City-County Health Department or the City Fire Marshal's office.

Air Pollution in Region IV

The Trans-Pecos area occupies the extreme western part of Texas and is very diverse in character. There are extensive plains and basins, but high plateaus, isolated peaks and mountain ranges occur throughout the greater part of this area. All of the Trans-Pecos area is very sparsely inhabited and vegetated except for the El Paso area; therefore, only El Paso will be treated in detail.

El Paso

El Paso, the county seat of El Paso County, is the largest city on the entire United States-Mexico boundary line, having as its twin city, Cuidad Juarez, the largest Mexican city on the boundary line.

Of a total population in the Trans-Pecos region of approximately 242,000 in 1950, over 80 percent (about 195,000) lived in El Paso County.[3] The area is primarily (75 percent) urban. The city planning department predicted a county population of 299,000 for 1957, 361,000 for 1960 and 453,000 by 1970. The estimated city population for 1957 was 255,000.

El Paso has a very diversified economy; varied industries, farming and ranching, transportation, wholesale distribution, export and import trade, government expenditures and tourist trade all contribute.

In 1954, there were 180 manufacturing establishments, employing 9,232 people and providing a payroll of $28,534,000.[25] The value added by manufacturing was over 51 million dollars. The clothing industries hold the top spot in manufacturing in the city from the standpoint of number of workers, with approximately 4,200. Other components of El Paso's industrial structure include refineries, smelters, a cement plant, meat packing plants and other food establishments. The major potential sources of pollution in El Paso are the two oil refineries, a fertilizer plant using spent refinery acid, a large smelter and a cement plant. The majority of the complaints received by the local health department have been on odor from the refineries and fertilizer plants, sulfur compounds from the smelter and particulate matter from the cement plant. However, particulates, (lead, copper, arsenic and antimony) are potential problems from the smelting operations.

Crops produced from the rich lands of the Rio Grande Valley have been important to the economic development of the City, with cotton and alfalfa being the leading crops. Cotton ginning operations in the county had not caused any previous complaints, but with increasing population in the area, these may be future problems.

Three major military installations—Fort Bliss, Biggs Air Force Base and William Beaumont Army Hospital—are major factors in the local economy. Also tourists spend an average of well over $30 million annually with El Paso's hotels, motels, restaurants and merchants.

The major fuel used for heating is gas, although some oil may be burned. Coal is of very minor significance. No problems were associated with fuel consumption. The county automobile registrations were: 26,770 in 1940; 47,390 in 1950; and 93,788 in 1956.[15] However, with so large a tourist trade, the operating vehicles in the area could far exceed these registrations. For example, 22,298,921 people crossed the border in 1956, and one would expect quite a large amount of this to be by automobile. Therefore, a traffic survey of the area would be necessary to determine the actual number, movement and motor fuel consumption of vehicles in the city.

Fire and garbage ordinances of El Paso prohibit any burning of refuse, garbage or rubbish, except in approved incinerators. Only a few commercial incinerators exist, and these emit no significant amount of smoke. The sanitary landfill method is used for disposal of refuse. For a while, the citizens were using dried sludge for composts in their yards to build up the soil. This created an odor and fly problem during summer months, but it has since been controlled by an ordinance prohibiting the practice during this period. A great deal of work has been done in an effort to reduce the air pollution level of El Paso.

In 1952, the mayor of El Paso, recognizing a growing air pollution problem, appointed a committee of five qualified citizens to study the problem. Assistance and advice were asked of the State Department of Health, and this was granted. Working through the Industrial Committee of the El Paso Chamber of Commerce, the mayor's committee sought as much voluntary improvement as was felt possible. The large industries (the smelter, cement plant and oil refineries) spent more than $500,000 during 1954 on air pollution control devices and an equal amount in 1955 and 1956. Several million dollars was spent by the railroads in dieselizing all of their motive power during 1952-54. Several thousands of dollars was spent by the largest construction materials company and the fertilizer plant for air pollution control equipment. One lumber company abandoned their incinerator, and wood waste was disposed of and used for agricultural purposes. This one act has helped to diminish the total visible smoke over the city.

In 1954, an Industrial Betterment Committee was formed. The objectives and work of this group are considered in detail under a previous section, "Air Pollution Ordinances and Control Programs."

In 1957, the El Paso-Hudspeth County Health Department was charged with the responsibility of making a detailed air pollution study of the City. A sampling program was then started to determine the type, extent and effect of the pollutants. The sampling program is explained under "Current Research and Investigations." A Public Health Service demonstration grant was received by El Paso to help finance this study.

There is a dual jurisdiction angle to the problem. South (and directly across the river) from El Paso is the city of Juarez, Mexico. Juarez is not an industrial city; it is noted for agriculture and as a tourist attraction. The Juarez Health Department receives numerous complaints from its citizens which involve primarily complaints of sulfur dioxide from industries in El Paso. At times, the prevailing winds would favor the transport of pollutants from El Paso across the border and vice versa.

APPENDIXES

(Enclosure With Letter
of Introduction)

OFFICIAL MEMORANDUM
by
PRICE DANIEL
GOVERNOR OF TEXAS

Austin, Texas

GREETINGS:

State health officials report that air pollution is becoming an increasingly complex health problem throughout Texas as a result of industrial expansion and daily activities of our steadily-increasing population. As our State continues to grow, the hazards of dusts, soot, smoke, fly-ash, noxious fumes and gases are likely to affect the health and welfare of the people of Texas. Air pollution is a source of grave economic waste.

Intelligent action involving medical practices, engineering, equipment, research and education can greatly diminish the hazards of air pollution. Engineers have devised and industry has employed many methods of air pollution control, resulting in improved health of their communities.

THEREFORE, I, as Governor of Texas, do hereby designate the week of October 20-26, 1957, as CLEANER AIR WEEK in Texas, and ask all persons to cooperate actively with the State Health Department in arousing public attention in the fight against air pollution.

In official recognition whereof, I hereby affix my signature this 16th day of October, 1957.

(Original signed by) Price Daniel

Governor of Texas

(Letter introducing the appraisal to the health officers)

State of Texas
Department of Health

HENRY A. HOLLE, M. D.
COMMISSIONER

AUSTIN

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ELMER C. BAUM, D. O.
J. T. STRYKER, PHARMACIST

December 16, 1957

Widespread interest is currently being expressed towards the field of air pollution. Increasing population and industrialization are resulting in more and more pollutants being discharged into the atmosphere. Urbanization is magnifying the problem. However, the contribution to air pollution by agricultural practices is quite significant in the rural areas. All of these problems dictate the need for public health practices without retarding economic progress.

We are anxious to establish the facts, to the best of our ability, concerning the status of air pollution in Texas. Governor Price Daniel indicated his concern regarding this matter when, on October 16, 1957, he issued an official memorandum requesting "all persons to cooperate actively with the State Health Department in arousing public attention in the fight against air pollution." A copy of this memorandum is attached for your information.

This Department, in cooperation with the U. S. Public Health Service is undertaking an appraisal of the present and future potential air pollution problems of the State. Once we know the status of air pollution in Texas, we should be able to bring into proper perspective the overall situation and determine the need and scope of future activities on a state and local basis.

Your knowledge and information regarding your local area will be of material assistance to this appraisal. Accordingly, the Division of Occupational Health, which has had responsibility in this field for over a year, will be contacting you for your advice and help. The Division will also be available to you for advice and other assistance as requested, and will provide you with a copy of the resultant report.

Sincerely,

/s/ Henry A. Holle

Henry A. Holle, M.D.
Commissioner of Health

(Cover Letter for Health Officers Questionnaires)

State of Texas
Department of Health

HENRY A. HOLLE, M. D.
COMMISSIONER

AUSTIN

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J. T. STRYKER, PHARMACIST

As Doctor Holle has informed you, the Texas State Department of Health has undertaken an appraisal of the present and potential air pollution problems of the State. Specifically, we will consider such sources of pollution as transportation, heating, agricultural practices, refuse disposal, industry, residential, and natural causes. The influence of meteorology, geography, and topography will be evaluated and control measures and current air pollution practices will be incorporated into the study.

We are contacting all county and city health officers to obtain information regarding air pollution in each locality. Your knowledge and advice about your area are essential for the success of this study. Accordingly, we are asking that you complete and return the enclosed questionnaire. The information collected in this questionnaire will serve to call attention to problem areas requiring more specific study.

Your earliest practicable return of the questionnaire will be greatly appreciated.

Sincerely,

/s/ W. L. Wilson

W. L. Wilson, M.D., Director
Division of Occupational Health

TEXAS STATE DEPARTMENT OF HEALTH
Division of Occupational Health

HEALTH OFFICERS'
AIR POLLUTION APPRAISAL QUESTIONNAIRE

	Yes	No
1. Are there any operations (municipal, domestic, industrial) in your area of jurisdiction that emit objectionable amounts of smoke, fumes, dust or odor to the atmosphere?	( )	( )
2. In your opinion are these pollutants present in sufficient concentrations to cause:		
a. Discomfort or inconvenience to residents?	( )	( )
b. Damage to property? (autos, paint, clothing, buildings, etc.)	( )	( )
c. Damage to vegetation?	( )	( )
d. Injury to animal life?	( )	( )
3. Has your office received complaints concerning air pollution during the past two years?	( )	( )
4. Are the air pollution problems in your area of jurisdiction principally due to:		
a. Municipal activities (city dumps, incinerators, etc.)	( )	( )
b. Domestic activities (incinerators. home heating plants, etc.)	( )	( )
c. Commercial activities (service industries, hotels, laundries)	( )	( )
d. Industrial activities	( )	( )
e. Agricultural Practices	( )	( )
f. Natural sources	( )	( )
5. Please describe briefly any air pollution problems in your jurisdiction. (Use reverse side if necessary.)		
6. In your opinion is the problem described above of major ( ) or minor ( ) significance?	( )	( )
7. Are there any local ordinances, exclusive of nuisance regulations, for the control of smoke, fumes, dust or odor?	( )	( )
8. Have any steps been taken in your area of jurisdiction to control sources of air pollution?	( )	( )
9. Are there sources of air pollution outside of your area of jurisdiction which have created a problem in your area?	( )	( )
10. Please list any other groups (official or unofficial) in your area of jurisdiction who might furnish additional information regarding air pollution problems.		

Return in self-addressed envelope.

Signed: ....

Title: ....

City: ....

County: ....

January 1958

(Cover Letter for Industrial
Questionnaire)

State of Texas
Department of Health

HENRY A. HOLLE, M. D.
COMMISSIONER

AUSTIN

BOARD OF HEALTH
J. B. COPELAND, M. D., CHAIRMAN
F. W. YEAGER, M. D., VICE-CHAIRMAN
JOE B. WINSTON, B. S., SECRETARY
R. W. KIMBRO, M. D.
A. C. SLOAN, D. D. S.
HAMPTON C. ROBINSON, M. D.
WILLIAM HIBBETTS, M. D.
ELMER C. BAUM, D. O.
CYRUS H. LAMBERT, PHARMACIST

March 1958

Gentlemen:

We regret that we are unable to visit your firm personally to present the following matter, but staff limitations prevent this.

As you are probably aware, widespread interest is currently being expressed towards the field of air pollution. Here in Texas, we are anxious to establish the facts, to the best of our ability, concerning the situation in our state.

This department, in cooperation with the U. S. Public Health Service, is undertaking an appraisal of the present and potential air pollution problems of the state. Our goal is to bring into proper perspective the overall situation and determine the need and scope of future activities on a state and local basis.

Accurate industrial information is needed so that it may be placed in its proper relationship with other sources such as: transportation, agricultural practices, domestic activities, refuse disposal, natural sources, etc. Your knowledge and information about your own particular installation can be most helpful and is essential to our staff for a realistic approach to the actual situation.

The enclosed "Industrial Questionnaire" is designed to obtain general information by areas as to the types and sizes of industries and to the control activities accomplished. The information will not be reported in detail nor referred to as a specific industrial establishment by name.

We urgently request your cooperation in completing the questionnaire and returning it at your earliest convenience. The extra copy is for your records.

Your interest and voluntary cooperation will be of material assistance.

Sincerely,

/s/ W. L. Wilson

W. L. Wilson, M.D., Director
Division of Occupational Health

TEXAS STATE DEPARTMENT OF HEALTH
Austin, Texas

AIR POLLUTION APPRAISAL—INDUSTRIAL QUESTIONNAIRE
February 1958

1. Name of firm ....

   Address ....

   ....

2. Describe general location of plant in relation to nearest community. (Is it north, south, east, west; how far from center of town?)

....

....

3. Type of Manufacturing: ....

4. Major Products — Estimated Annual Consumption**

Major Products	Estimated Annual Consumption**
....	....
....	....
....	....

5. Major Raw Materials — Estimated Annual Consumption**

Major Raw Materials	Estimated Annual Consumption**
....	....
....	....
....	....

6. Fuel Consumption:

Type	Estimated Annual Consumption**
....	....
....	....

7. a. Have any evaluations been made with regard to the discharge of waste materials to the atmospherse? ....

   b. Would you be willing to make the resultant information available to official agencies? ....

8. What control methods are currently being used to prevent a discharge of waste materials into the atmosphere? (Examples: Bag filters, Cyclone collectors, Wet scrubbers, Electrostatic precipatators, etc.)

9. Do you plan to install any new control equipment in the near future? ....

   If so, explain: ....

10. Will you wish a summary of the results of the Texas Appraisal? ....

** Your reply on this item is voluntary, but if you feel free to give it, our results will be much more adequate and accurate. Please complete the remainder of the questionnaire regardless of your reply on this matter.

PLEASE RETURN IN THE SELF-ADDRESSED ENVELOPE

APPENDIX B

EXAMPLES OF POLLUTION EMISSION RATES

TABLE 41

EXAMPLES OF POLLUTION EMISSION RATES

The data presented in this table are of value only as general information on the composition and magniture of pollution from the several activities. They should not be applied to any specific situation with due consideration of the many factors which affect pollution emissions.

FUEL GAS AND OIL[56]

Component	Measured As:	Pounds of Pollutants Per 1000 Pounds of Material Burned	
		Gas (a)	Oil (b)
Aldehydes	CHO	1.0	1.3
Nitrogen Oxides	NO_2	6.9	13.5
Sulfur Oxides	SO_2	......	30.0
Acids	Acetic	1.3	13.5
Organics	....	1.4	4.6

(a) 1000 lbs. of gas is equivalent to approximately 21,785 cubic feet.
(b) 1000 lbs. of No. 2 fuel oil is equivalent to approximately 140 gallons.

COAL

Component	Measured As:	Pounds Emitted Per Ton of Coal Burned
Solids	......	200
Sulfur Oxides	SO_2	40
Nitrogen Oxides	NO_2	8
Organics	......	20
Acids	Acetic	30

AUTOMOBILE ENGINES[56, 57]

Component	Measured As:	Pounds of Pollutants Per 1000 Pounds of Gasoline	
		Ref. 56	Ref. 57
Aldehyde	CHO	2.8	3.0
Ammonia	NH_3	0.3	0.3
Nitrogen Oxides	NO_2	12.3	4.0
Sulfur Oxides	SO_2	2.8	2.8
Acid	Acetic	0.3	0.3
Organics	......	70.7	30.0
Solids	Carbons	......	0.05

TABLE 41 (Continued)

DIESEL ENGINES[58]

Component	Measured As:	Pounds Emitted Per 1000 Lbs. of Diesel Fuel Burned
Particulates	......	17
Nitrogen Oxides	NO_2	24.5
Sulfur Oxides	SO_2	5
Lower Aldehydes	Formaldehyde	2.5
Organic Acids	Acetic	5

GASOLINE HANDLING LOSSES[59]

10,400 pounds loss per 100,000 gallons of gasoline handled including evaporation losses from marketing, filling service station tanks, filling automobile tanks, and automobile carburetors.

HOUSEHOLD INCINERATORS[56]

Component	Measured As:	Pounds Emitted Per 100 Lbs. of Material Burned
Aldehyde	CHO	1.8
Ammonia	NH_3	0.8
Nitrogen Oxides	NO_2	0.2
Sulfur Oxides	SO_2	0.4
Acids	Acetic	0.4
Organics	......	81.8

MUNICIPAL INCINERATORS[60]

Component	Measured As:	Pounds Emitted Per 100 Lbs. of Maturial Burned
Organics	......	0.06
Aldehydes	Formaldehyde	0.07
Acids	Acetic	0.03
Sulfur Oxides	SO_2	0.1
Nitrogen Oxides	NO_2	0.1
Ammonia	NH_3	0.02
Solids	......	1.2

APPENDIX C

WIND ROSES[31, 35]

SOURCES OF CLIMATOLOGICAL DATA

FIRST ORDER U. S. WEATHER BUREAU STATIONS

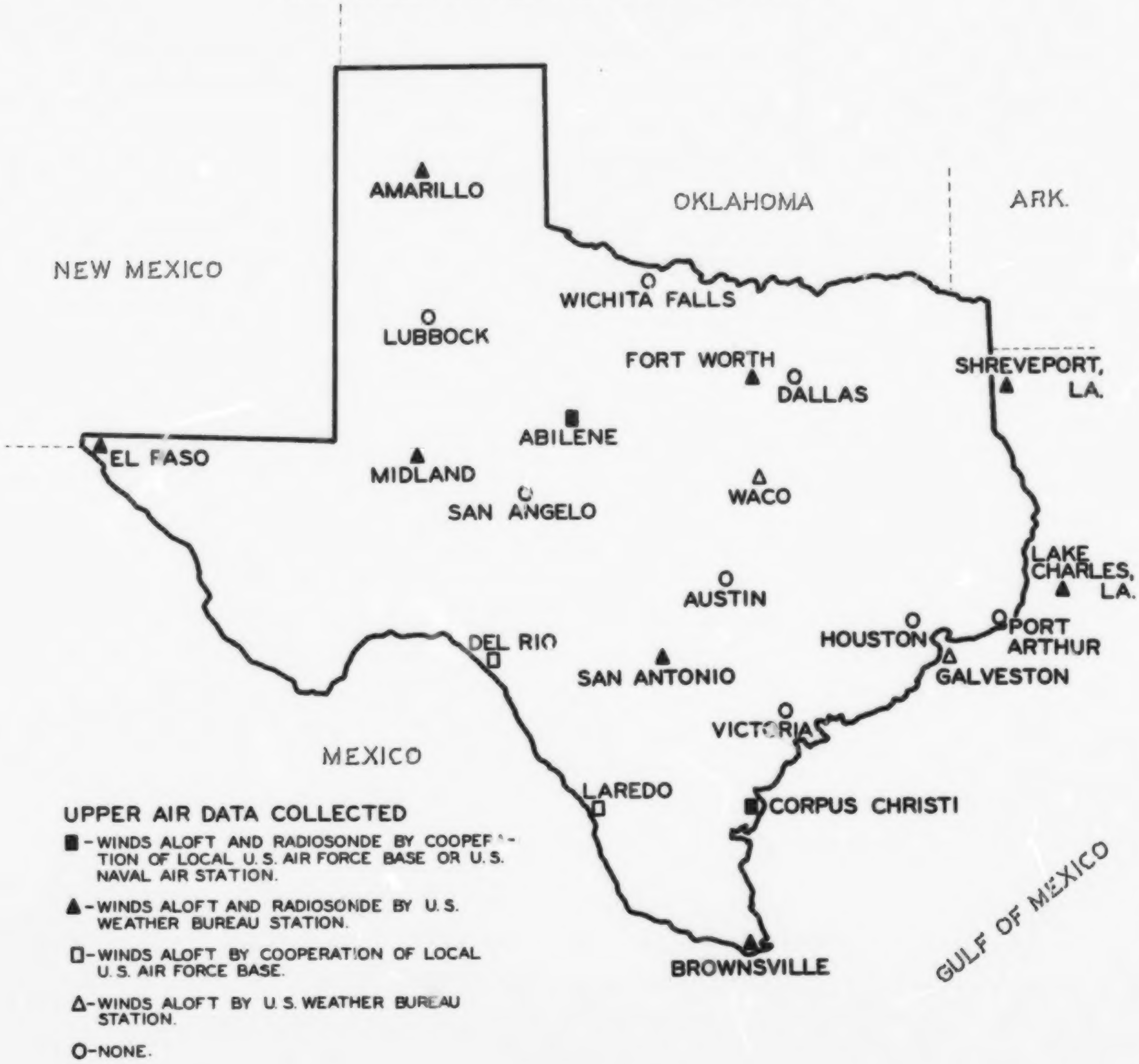
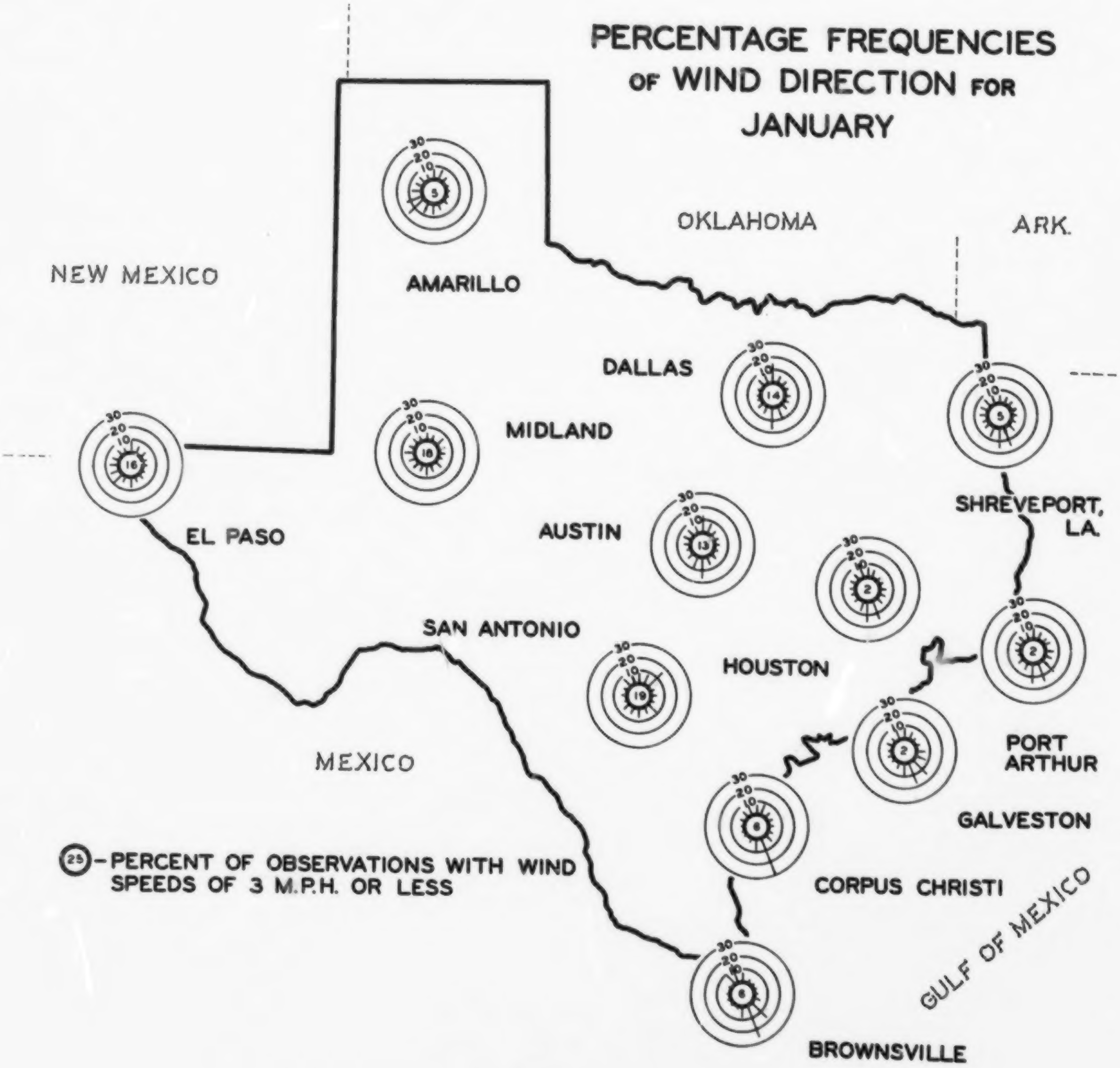

OKLAHOMA
ARK.
NEW MEXICO
AMARILLO
WICHITA FALLS
LUBBOCK
FORT WORTH
DALLAS
SHREVEPORT, LA.
ABILENE
EL PASO
MIDLAND
SAN ANGELO
WACO
LAKE CHARLES, LA.
AUSTIN
HOUSTON
PORT ARTHUR
DEL RIO
SAN ANTONIO
GALVESTON
VICTORIA
MEXICO
LAREDO
CORPUS CHRISTI
GULF OF MEXICO
BROWNSVILLE
UPPER AIR DATA COLLECTED
■ - WINDS ALOFT AND RADIOSONDE BY COOPERATION OF LOCAL U. S. AIR FORCE BASE OR U. S. NAVAL AIR STATION.
▲ - WINDS ALOFT AND RADIOSONDE BY U. S. WEATHER BUREAU STATION.
□ - WINDS ALOFT BY COOPERATION OF LOCAL U. S. AIR FORCE BASE.
△ - WINDS ALOFT BY U. S. WEATHER BUREAU STATION.
○ - NONE.

FIGURE 13

WIND ROSES



PERCENTAGE FREQUENCIES OF WIND DIRECTION FOR JANUARY

NEW MEXICO
OKLAHOMA
ARK.
AMARILLO
DALLAS
MIDLAND
EL PASO
AUSTIN
SHREVEPORT, LA.
SAN ANTONIO
HOUSTON
PORT ARTHUR
GALVESTON
CORPUS CHRISTI
BROWNSVILLE
MEXICO
GULF OF MEXICO
30
20
10
5
14
5
16
18
13
2
2
19
2
25 - PERCENT OF OBSERVATIONS WITH WIND SPEEDS OF 3 M.P.H. OR LESS

FIGURE 14

WIND ROSES

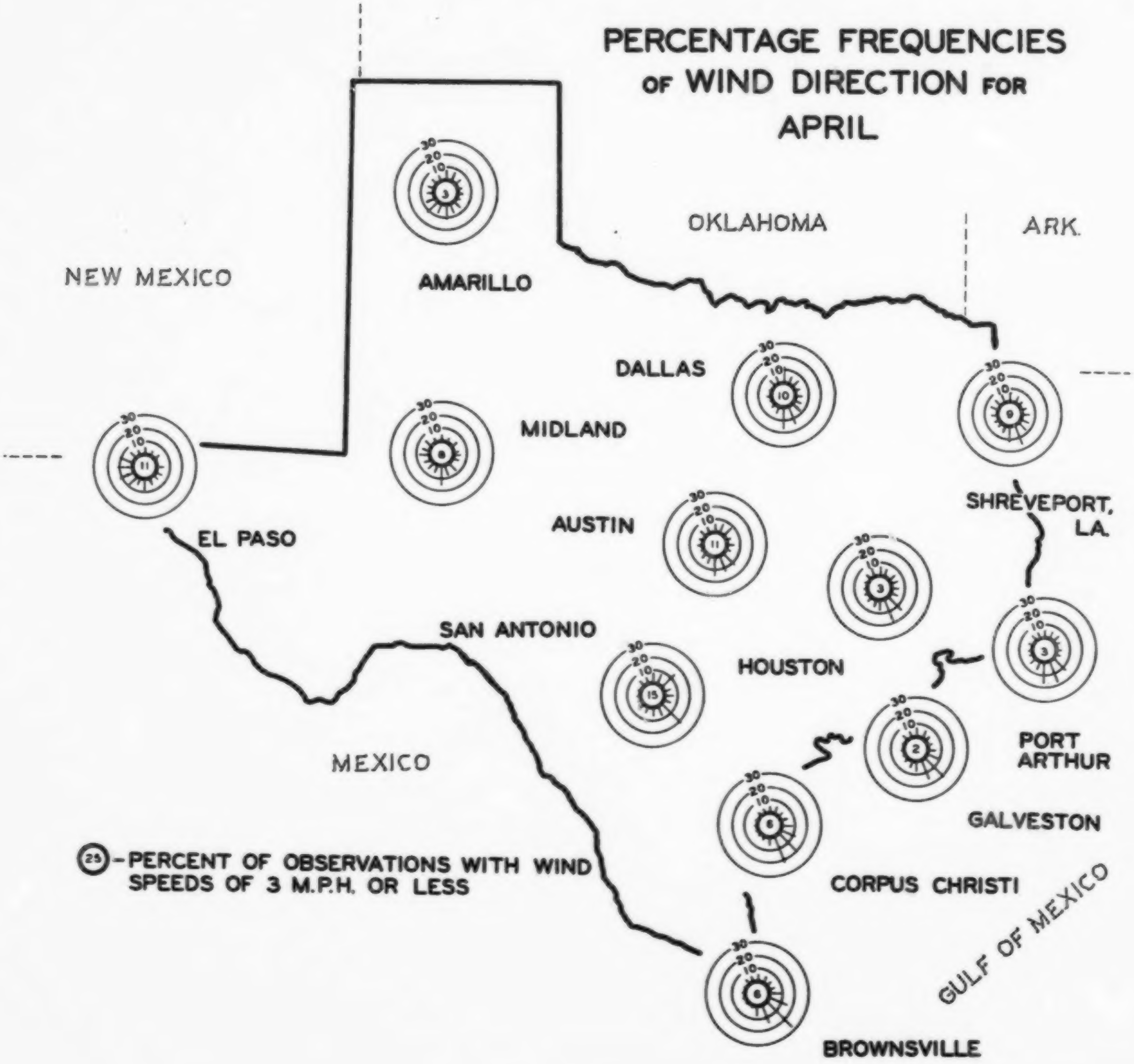
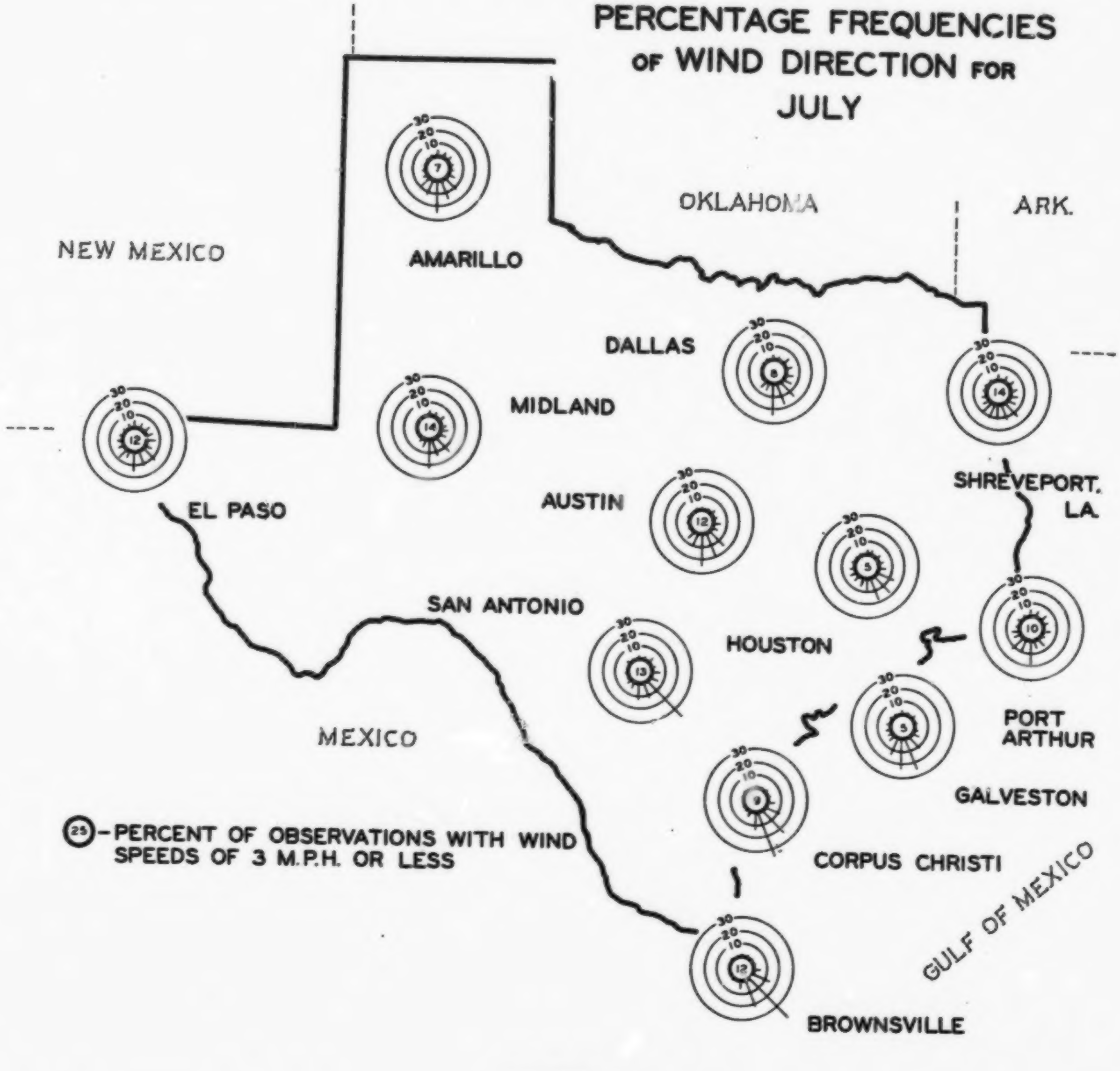

PERCENTAGE FREQUENCIES
OF WIND DIRECTION FOR
APRIL
NEW MEXICO
OKLAHOMA
ARK.
AMARILLO
DALLAS
MIDLAND
EL PASO
AUSTIN
SHREVEPORT, LA.
SAN ANTONIO
HOUSTON
PORT ARTHUR
GALVESTON
CORPUS CHRISTI
BROWNSVILLE
MEXICO
GULF OF MEXICO
30
20
10
25 - PERCENT OF OBSERVATIONS WITH WIND SPEEDS OF 3 M.P.H. OR LESS

FIGURE 15

WIND ROSES

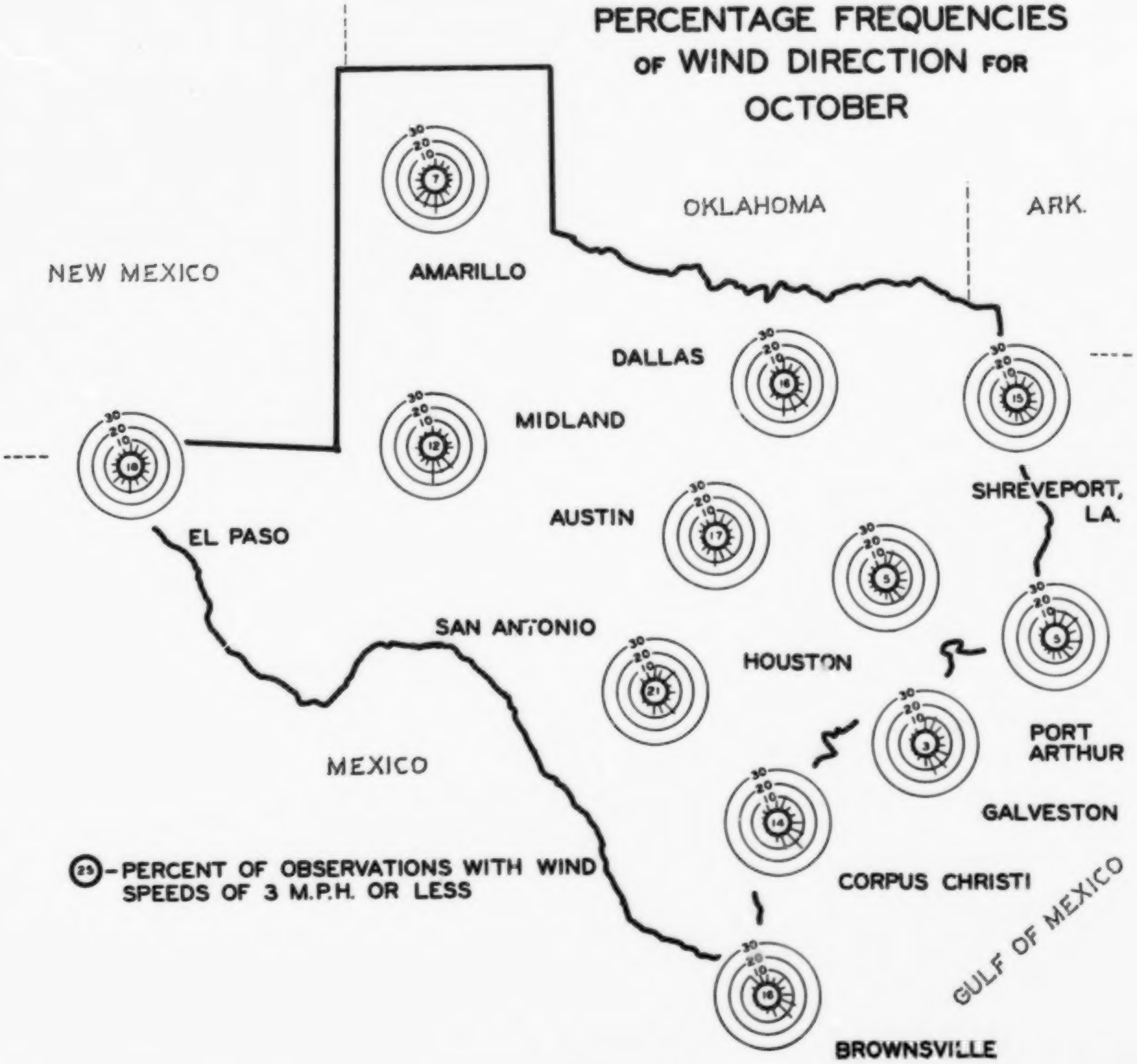

PERCENTAGE FREQUENCIES OF WIND DIRECTION FOR JULY

NEW MEXICO
OKLAHOMA
ARK.
AMARILLO
DALLAS
MIDLAND
EL PASO
AUSTIN
SHREVEPORT, LA.
SAN ANTONIO
HOUSTON
PORT ARTHUR
GALVESTON
CORPUS CHRISTI
BROWNSVILLE
MEXICO
GULF OF MEXICO
30
20
10
7
12
14
8
14
12
5
13
10
5
12

㉕-PERCENT OF OBSERVATIONS WITH WIND SPEEDS OF 3 M.P.H. OR LESS

FIGURE 16

WIND ROSES



PERCENTAGE FREQUENCIES OF WIND DIRECTION FOR OCTOBER

NEW MEXICO
OKLAHOMA
ARK.
AMARILLO
DALLAS
MIDLAND
EL PASO
AUSTIN
SHREVEPORT, LA.
SAN ANTONIO
HOUSTON
PORT ARTHUR
GALVESTON
CORPUS CHRISTI
MEXICO
GULF OF MEXICO
BROWNSVILLE
30
20
10
7
12
18
16
15
17
5
21
5
3
14
16
㉕ - PERCENT OF OBSERVATIONS WITH WIND SPEEDS OF 3 M.P.H. OR LESS

FIGURE 17

APPENDIX D

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES[45]

November 1, 1957

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES

State	Date	Scope
California	June 1947	(AB#1) This is the basic air pollution control district bill providing for officers of the district; prohibitions; promulgation of rules and regulations; permits; procedures; variances.
California	June 1955	(SB#117) This act adds an article (9) to the Health and Safety Code providing for an air sanitation program. This program includes: studies to determine the health effects of air pollution; the physiological effects of air air pollution upon plant and animal life; the determinations of factors responsible for air pollution; the monitoring of air pollutants; the development of administrative means of control of air pollution in emergencies; assistance to local agencies and authority to enter into agreements with private and public agencies, etc., with respect to air sanitation.
California	April 29, 1957	Chapter 236, contains amendments which provide that the Air Pollution Control Officer shall observe and enforce within this Air Pollution Control District all provisions of the vehicle code relating to the emission or control of air contaminants. In enforcing these provisions, the Air Pollution Control Officer is a peace officer. Another amendment grants the right of entry to the Air Pollution Control Officer in enforcing those provisions of the vehicle code relating to the emission or control of air contaminants. Chapter 237, amends section 24245 of the Health and Safety Code exempts from the smoke density prohibitions the smoke from fires set for certain purposes. Chapter 238, amends section 24265 of the Health and Safety Code which exempts certain equipment from the requirements to secure a permit. Chapter 239, adds section 24263.7 to the Health and Safety Code which authorizes the Air Pollution Control Board to regulate, by establishing standards of performance, any equipment, etc., intended for installation upon or in any motor vehicle for purpose of eliminating, etc., the issuance of air contaminants. This section also prohibits the sale of such equipment unless approved by the Air Pollution Control Officer.

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES (Continued)

State	Date	Scope
California	May 21, 1957	Chapter 501, amends section 24254 of the Health and Safety Code which exempts officers or employees of any State or local government agency or public district from criminal liability or responsibility for any acts done in the performance of their duties. It does permit injunction, however, by civil action against any governmental agency, public district, employee or officer thereof, for violation of any order, rule or regulation.
Colorado	March 13, 1957	This bill amends the basic Colorado Public Health Law authorizing the Colorado Department of Public Health to establish standards governing discharge to the atmosphere of toxic materials in solid, liquid or gaseous phase including radioactive materials.
Delaware	June 13, 1957	This act creates an Air Pollution Authority administered by the State Board of Health. The authority is given to develop a comprehensive program for the prevention and control of air pollution, in addition to research and technical assistance activities.
Florida	June 18, 1957	This act creates an air pollution control commission in the State Board of Health. The commission is authorized to create, within the State, Air Control Districts in accordance with a prescribed procedure. The State Board of Health acting for the commission has a research and technical assistance responsibility on a State-wide basis and additional specific functions and powers in Air Control Districts.
Hawaii	May 6, 1957	The Territorial Board of Health is authorized to formulate and promulgate rules and regulations controlling and prohibiting air pollution throughout the Territory or such parts thereof as may be affected. A section of air pollution control is established and a program of research, air pollution control education in addition to control activities is authorized. Provision is made for the formation of county advisory air pollution control associations.
Kentucky	March 1952	This act is one which enables the formation of air pollution control districts and provides the procedure for its activation and organization; appropriations to the districts by the counties and cities of the first and second classes is authorized; emission of air contaminants in excess of the limits established herein is prohibited; provision is also made for the procedural aspects.

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES (Continued)

State	Date	Scope
Massachusetts	June 1954	The Department of Public Health is authorized to establish minimum rules and regulations to control pollution of the air. Provision is made to comply with the due process of laws by means of specifying the appropriate procedural aspects. The Department has jurisdiction to control air pollution where more than one municipality is involved.
Minnesota	April 10, 1957	This act relates to the powers of the State Board of Health authorizing the Board to make regulations relating to atmospheric pollution control. These regulations have the force of law except where they conflict with a statute, or with the charter or ordinance of a city of the first class upon the same subject. It is to be noted that the regulatory authority is restricted to amospheric pollution which may be injurious or detrimental to public health.
Nevada	March 18, 1957	This act enables the board of county commissioners, and the governing bodies of incorporated cities to regulate, control and prohibit by ordinance the excessive emissions of dense smoke and air pollution by soot, cinders, fly-ash, dust, noxious acids, fumes and gases. It also permits entering into cooperative agreements between the counties and cities for these purposes in terms of joint usage of personnel, equipment and facilities.
New Hampshire	1955	This act provides for limited tax exemption as determined by the Water Pollution Commission for facilities, etc., which wholly or partly reduce, control or eliminate any source of air pollution.
New Jersey	September 1954	This act creates an air pollution control commission within the State Health Department who is charged with the enforcement of rules and regulations adopted by the commission for the control of air pollution through the State. In addition to providing for the powers, functions, and duties of the commission, authorization is also given for the appointment of county air pollution control associations for the study of local problems. Provision is also made for the promulgation of rules and regulations relating to the control of air pollution in a limited geographical area.
New Jersey	June 26, 1957	This act relates to the study of smoke and air pollution by the Interstate Sanitation Commission and extends the period of the final report to February 1, 1958.

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES (Continued)

State	Date	Scope
New York	April 13, 1957	This act relates to the study of the Interstate Sanitation Commission of Smoke and Air Pollution. It requires a report by March 31, 1958, presenting findings and recommendations for a smoke and air pollution control program. It also requires a study and evaluation of existing laws in the State of New York, New Jersey, and Connecticut and a draft of proposed legislation.
New York	April 25, 1957	This act amends the Public Health Law and created an Air Pollution Control Board in the State Department of Health. A policy is also established that rules, regulations or codes established under this law should be clearly premised upon scientific knowledge of causes as well as effects. In this connection the law prevents the promulgation of such codes, rules and regulations and their enforcement for a period of two years from the effective date of the act.
Ohio	June 10, 1957	This act relates to the activities of the State Department of Health. These activities are principally that of research, technical assistance, maintenance of a laboratory, and dissemination of information.
Oregon	1951	The Oregon Air Pollution Act creates an additional division in the State Board of Health known as the Air Pollution Authority. The Act provides for the duties of the Authority which include in addition to others, the development of a comprehensive program; consultation with other agencies; conduct of studies, investigations and research and the promulgation of rules and regulations. Procedural aspects as it relates to hearings, etc. are also included.
Pennsylvania	June 1911	This act authorizes cities of the second class to control smoke emissions.
Pennsylvania	1927	This act authorizes boroughs to control smoke emissions.
Pennsylvania	1931	This act authorizes townships of the first class to control smoke emissions.
Pennsylvania	July 1953	This act authorizes counties of the second class to regulate the production or emission of smoke from any source in the county. Provision is made for the collection of fees, examination of plans, issuance of permits, and inspection of fuel burning devices. Inspectors and other personnel are appointed by the Board of County Commissioners.

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES (Continued)

State	Date	Scope
Rhode Island	April 1946	Authorization is given city councils and town councils for the regulation of the pollution of the air in such city or town by ordinance. The act requires such ordinances to define the extent of smoke or other air pollution which is forbidden, and may also provide for right of entry and the requiring of permits and fees. The smoke inspector or other officer may also adopt rules and regulations provided a public hearing is held prior to promulgation.
Washington	March 23, 1957	This act, in brief, established the procedures for control of air pollution on a local basis. It also provides for the creation of separate districts for this purpose. Activity on a State level is limited to suggesting, advising, recommending, and cooperating with the governing body of any city, town or county as to the need and procedures for such tests to determine the degree of air pollution in its respective jurisdictions.
Wisconsin	April 1953 (amended 1957 to include radioactive fractions or their counterparts)	This act authorizes a county having a population in excess of 500,000 persons to regulate by ordinance the emission into the air of smoke and other pollutants. Authority is given to examine plans, issue permits, prescribe fees, etc. A county department of air pollution regulation and staff is authorized.
Wisconsin	May 1953	This act provides for an accelerated amortization rate on investments in facilities designed to control pollution of the air for income tax purposes and exempts such facilities from property taxes for five years.

December 9, 1957
Supplement # 1 to Listing of 11-1-57

AIR POLLUTION CONTROL LEGISLATION OF OTHER STATES

State	Date	Scope
Maryland	June 1950	(Section 115A of Article 43 of the Maryland Annotated Code Maryland Laws—Chapter 20) The Governor is authorized and directed to place in the budget each regular session an item, not to exceed $100,000 for the State Health Department for the study and control of air pollution. At least one-half of such appropriation shall be made aavilable to the Health Department of the City of Baltimore for that purpose.
North Carolina	1917	(Chapter 160—General Statutes of North Carolina) All cities have the power to regulate the emission of smoke within the city. Prohibits enactment of a regulation relating to smoke emissions by employees of a railroad company, when making necessary smoke in the stoking or operating of a coal burning locomotive.
South Carolina	1926	(Title 32—Code of Laws of South Carolina—1952—Vol. 3) In counties which have a city of 65,000 or more inhabitants, this act prohibits the discharge into the air of fumes from the manufacture of acids or other distillations which are of a corrosive nature or acrid odor, and offensive or dangerous to human or plant life, without first treating such emissions to render them innocuous, inoffensive and harmless.

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